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Closed Pneumonolysis (Enucleation Technique)*

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In 1913, Jacobeus,[17] of Stockholm, first performed closed pneumonolysis. This operation, done through very small incisions with the aid of a telescope, was designed to supplant open pneumonolysis, introduced by Friedrich in 1908. The latter operation, performed through a large incision in the chest wall, had been complicated frequently by pleural infection, hemorrhage, and subsequent obliteration of the pneumothorax space.

Since Jacobeus' original work, many surgeons throughout the world have written of their extensive experiences with this procedure—particularly Gustav Maurer[20] in Switzerland, Unverricht[31] in Germany, Roberts,[25] Peter Edwards,[11] and Brock[6] in England, and Alexander,[1] Goorwitch,[14] and Matson[19] in this country. These and other surgeons have, by technical improvements and increasing experience, widened the scope and safety of the operation until at the present time no adequate pneumothorax program can exist without it.

The technique of closed pneumolysis is difficult to learn because of its endoscopic nature. In the hands of an untrained or inexperienced surgeon it may be the most difficult and, potentially, one of the most dangerous operations to perform properly, requiring infinite patience and attention to detail. There is, therefore, a tendency for some surgeons to deny its value—particularly in cases with extensive adhesions—and to turn rather to thoracoplasty or resection. No one, however, can deny the great value

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to the patient of a successful pneumothorax collapse in preference to the more extensive surgical procedures.

As the surgeon gains skill, experience, and judgment and progresses from dividing simple string adhesions to operations on more complicated adhesion systems, the results usually improve and the scope of the procedure widens greatly. The safety of the operation in skilled hands from the viewpoint of mortality and complications is gratifying.

Brock quotes Chandler (1935),[7] "Endoscopic division of pleuropulmonary adhesions or internal pneumonolysis would be used more frequently if physicians were convinced that the operation could be performed with safety, that the results were good, that the operation was no ordeal to the patient, that severe reactions need not occur."

Indications for Closed Pneumonolysis. In recent years great stress has been laid on the pleural complications and permanent functional crippling of a lung which may attend the continuance of an ineffective pneumothorax, especially if adhesions prevent adequate relaxation and collapse of the diseased portion of the lung while the healthy portions are collapsed. There is general agreement that pneumonolysis is indicated in pneumothorax cases in which cavity closure and sputum conversion are prevented by adhesions. However, opinion is divided regarding this type of intervention in cases in which the cavity has apparently closed and the sputum has become converted but in which there is poor anatomical collapse, with the diseased part of the lung prevented by adhesions from collapsing completely.

Many physicians have by now had the opportunity to observe the end results of pneumothorax therapy with and without pneumonolysis. The general conclusion would seem to be that the so-called "clinically successful" pneumothorax with cavity closure and conversion of sputum despite the presence of adhesions is less likely to yield a permanent good result after cessation of the treatment and expansion of the lung than may be expected in cases in which a complete pneumothorax was obtained with no adhesions or in which all adhesions were severed. The reports of Veran,[32] Hurst and Schwartz,[16] and others, all point to the importance of obtaining as complete a release of the lung as possible and contradict the belief that it is sufficient to divide only the "key" adhesions which seem to be preventing cavity closure.

Franz,[13] in a study of microscopic sections, found unhealed foci of tuberculosis only in those parts of the lung that had been held out by adhesions. From this, Alexander concludes that the localized trauma of respiratory movements upon the lesions is probably the cause of the harmful effect of isolated adhesions

upon non-cavernous lesions. Rafferty,[24] finds that "it seems clear . . . . that many of the most experienced observers now believe that sputum conversion and apparent cavity closure can no longer be construed as indicating that restraining adhesions are having no harmful effect on parenchymal disease." Andosca and Foley,[3] state, "It is our opinion that any adhesions preventing a satisfactory collapse, irrespective of a positive or negative sputum, are an indication for pneumonolysis."

A selective collapse of the diseased portion of the lung should be the object of pneumothorax and pneumonolysis. However, a word of caution must be interjected concerning the division or enucleation of extensive adhesions in a patient whose collapse is clinically successful, with cavity closure and sputum conversion. The limits of safety in any such operation depend upon the skill and experience of the operator. We are cautious when operating upon such a case. However, string and band adhesions and adhesions requiring only a small enucleation should be divided to attain a more selective collapse.

Active lesions in the contralateral lung do not contraindicate closed pneumonolysis provided, according to Alexander, that the lesions are presumably curable with or without collapse therapy. The operation may be done while the other lung is being treated by pneumothorax or after a contralateral thoracoplasty of excision. In our opinion, bilateral cases offer the field of greatest

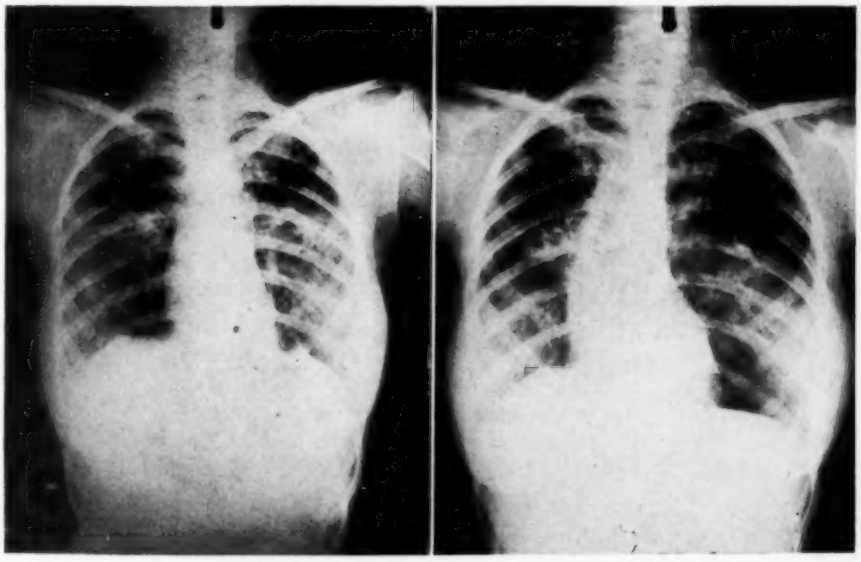

FIGURE 1a FIGURE 1b

Fig. 1a: Extensive bilateral disease. August 17, 1939.
Fig. 1b: Left pneumothorax with adhesions. December 16, 1939.

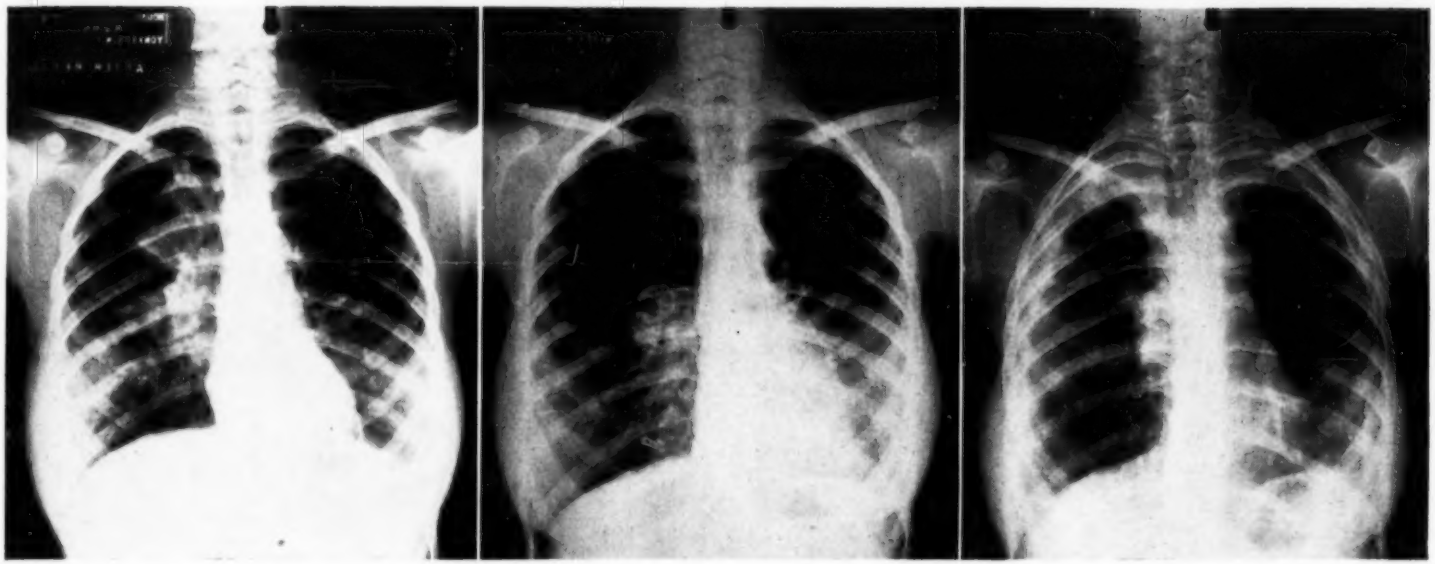

FIGURE 1c FIGURE 1d FIGURE 1e

Fig. 1c: Satisfactory collapse on left side after closed pneumonolysis. Collapse of right lung hindered by thick columnar apical adhesions. August 17, 1940.—*Fig. 1d:* Satisfactory bilateral collapse. March 1, 1941.—*Fig. 1e:* After voluntary reexpansion of both sides. October 2, 1948.

applicability of extensive close pneumonolysis, as exemplified in the following case:

Case 1: C.S., a 19-year-old female, was admitted in June, 1939 with bilateral cavernous tuberculosis (Figure 1a). Left therapeutic pneumothorax was induced in October, 1939 (Figure 1b). A closed pneumonolysis with extensive enucleation was performed in February, 1940. Thoracoscopy was done again in March, 1940 but no adhesions were seen which required division. A right pneumothorax was induced, but the sputum remained positive and in August, 1940 (Figure 1c) a right closed pneumonolysis was performed, during which a thick, lung-containing, apicomediastinal adhesion was enucleated. There were no pleural complications on either side and the sputum became negative for tubercle bacilli in June, 1941 (Figure 1d).

Subsequently, both pneumothoraces were continued to May, 1947, when they were voluntarily ended. During the period of treatment the patient carried on a moderately restricted but fairly normal mode of life. Both lungs reexpanded well after abandonment of the pneumothoraces and the sputum has remained negative (Figure 1e). There is no evidence of active pulmonary disease and the patient is living a normal life.

Contraindications to Closed Pneumonolysis. Cases of ineffectual pneumothorax may be presented to a surgeon for pneumonolysis which, in his opinion, were not even good candidates for pneumothorax treatment. The two main groups into which these cases fall are:

(1) Cases of extensive and wide-spread disease, and
(2) Cases with a tuberculous stenosis of a major bronchus.

In either situation the contraindication to pneumothorax and pneumonolysis lies in the fact that subsequent lung reexpansion may be impossible and that it would have been better to have proceeded at once with a permanent collapse measure such as thoracoplasty, or with pulmonary resection.

Almost all cases of therapeutic pneumothorax show, at some time or other in their course, transient pleural effusions. Even though diligent search by culture and guinea-pig inoculation may reveal tubercle bacilli in almost all of these fluids, even when clear, they are not considered complications and pneumothorax therapy is continued. Many of these fluids will disappear after pneumonolysis. However, the appearance of a sizeable pleural effusion requiring repeated tapping, and exhibiting a tendency to recur, should call for a prompt evaluation of the case with a view to abandoning the pneumothorax before a grossly purulent effusion or marked pleural thickening occurs. Such complications present themselves most frequently in cases in which the pneumothorax has been maintained despite adhesions which render it incomplete. They constitute a strong argument in favor of routine thoracoscopy and pneumonolysis early in the course of

every incomplete pneumothorax. Pneumonolysis should not be undertaken when persistent turbid pleural fluid, marked pleural thickening, or evidence of progressive obliterative pleuritis are noted. If the formation of pleural fluid, with or without fever, is in the acute phase, operation should be postponed until the acute process has subsided.

Tuberculous and mixed-infection empyemata are generally regarded as contraindications, not only to pneumonolysis but also to continuation of pneumothorax therapy.

If, at thoracoscopy, a clinically unsuspected acute pleural inflammation is found it is better to avoid pneumonolysis since under such circumstances tuberculous empyema follows frequently. The presence of isolated tubercles on the parietal or visceral pleura or at the base of an adhesion is not a contraindication to pneumonolysis, according to Roberts, unless the tubercles are present at the contemplated line of adhesion section. The surgeon should use careful judgment in such cases before proceeding, weighing carefully the possible effects of a tuberculous empyema against the absolute necessity of obtaining a collapse in this manner. Other collapse or excisional procedures may be preferable.

Pleural thickening sufficient to obscure landmarks is a contraindication to division of any but thin cords or sheet adhesions that can be well transilluminated to show they do not contain lung. Short adhesions to the chest wall may be enucleated but usually when the pleura is thick an extrapleural cleavage plane is difficult to establish. Short adhesions or synechiae at the dome or in the mediastinal area should not be divided when the pleura is thick and the landmarks obliterated because of the danger of damage to the subclavian artery or other large vessel, or the thoracic duct. Under such circumstances it usually is better to reexpand the lung and do a thoracoplasty or to proceed at once with excision of the diseased lobe. Decortication[29] of the remaining lobe or lobes may be necessary to allow them to reexpand to fill the chest cavity.

Optimum Time for Operation. The optimum time for operation is from eight to 12 weeks after the induction of pneumothorax. During this time adhesions will have stretched and in the process will have obliterated many of their intrinsic small vessels. It is not advisable to wait longer than three months since the optimum number of cavity closures will have been obtained by then and pleural complications will begin to increase.

Maurer has pointed out that immediately following the induction of pneumothorax the pleura is pale, transparent and glistening, and adhesions are easily divided along the line of cleavage in the endothoracic fascia. As the pneumothorax proceeds, and

especially if an effusion forms, the pleura becomes dull and thickened; as a result the operation becomes more hazardous. Pushing a pneumothorax to stretch adhesions either before the operation or after an incomplete operation is not recommended.

Operability Once the need for pneumonolysis has become evident, the operability or inoperability of adhesions should not be determined radiologically. It is the usual experience to find at thoracoscopy many more adhesions than are visible on the roentgenograms, and adhesions which on the films seem to be thin sheets or strings may turn out to be the edges of extensive synechiae or thick adhesions. Contrariwise, patients in whom one may believe nothing can be done because of most extensive adhesions are found upon thoracoscopy to have a series of thin, overlapping sheets so that what has seemed on x-ray to be an extensive adhesion system is really simple to deal with. Consequently, every patient whose pneumothorax is inadequate or incomplete because of adhesions should be thoracoscoped in order to obtain the best information. The morbidity from thoracoscopy is so slight that no patient should be denied its advantages.

Despite the fact that many series of good results have been reported, the frequent reference to the complications of empyema and bronchopleural fistula has induced many surgeons to limit their procedure to the division of thin band and string adhesions. Since only a minority of cases (14 per cent[21]) present such adhesions exclusively, a large number of patients fail to have pneumonolysis because the adhesions are short or are seen to contain lung tissue. Failure to divide adhesions in unilateral cases may not be too significant since such patients may go on to thoracoplasty or excision, but a patient with bilateral disease may, under such circumstances, have lost the greatest hope for the arrest of the disease.

In 1930, Gustav Maurer[20] published an extensive work on the anatomy of adhesions in pneumothorax. He noted that the configuration of an adhesion is dependent upon the relative degree of fibrosis in the tissues at the parietal pleural attachment and in the adjacent lung, and on this premise he classified adhesions into four main groups recognizable grossly at operation.

A. Cord-like adhesions that show no broadening of either attachment, probably of recent development before the pneumothorax.

B. Adhesions with a broadened thoracic wall insertion; they are usually quite fibrotic and less likely to contain lung at the chest wall insertion.

C. Adhesions with a conical pulmonary insertion; the broad

pulmonary end always contains elongated pulmonary parenchyma.

D. Hour-glass shaped adhesions with broadening on both ends.

Maurer found that 75 per cent of the 37 adhesions he examined contained lung tissue. When one considers that adhesions usually occur over the most extensive and superficial disease, one should

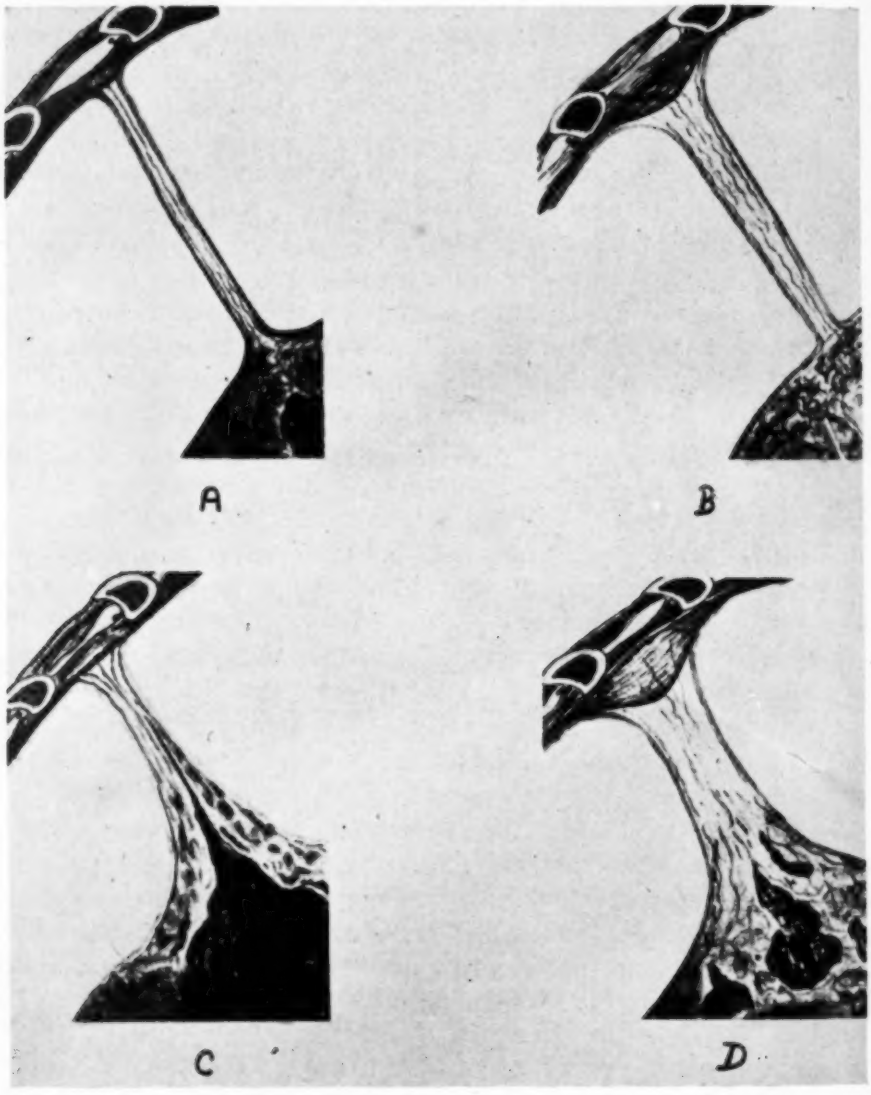

FIGURE 2: (A) "Uniform, formed from connective, especially granulation tissue. Lung infiltrated."—(B) "Formed from costal pleura and interpleural connective tissue. Lung shows anthrocotic scars."—(C) "Formed from interpleural connective tissue and lung parenchyma. Lung cavity taking part in it."—(D) "From costal pleura, connective tissue and lung parenchyma; breaking down foci in base of adhesions."—Reproduced from *Thorakoskopie und Kaustik*. Beitrage zur Klinik der Tuberkulose, 1930, 76, 9., by courtesy of G. Maurer, M.D., F.C.C.P.

not be surprised to find pulmonary tissue in an adhesion all the way to the thoracic wall. Maurer indicated that the usual technique of dividing an adhesion to leave a pulmonary and a pleural stump carried with it inevitably and frequently the complications of hemorrhage, empyema and bronchopleural fistula due to damage to strands of diseased lung tissue traversed by the incision. Accordingly, he elaborated his enucleation (or disinserting) technique to provide a means of freeing the adhesion by dissection entirely in the chest wall with consequent lessened danger of damaging the diseased parenchyma since the structure of the adhesion itself is in no way changed. Eloesser,[12] in 1924, had employed a similar principle in open pneumonolysis.

The adhesion section is carried out under thoracoscopic control in an extrapleural (or endothoracic fascial) plane and the entire freed adhesion retracts into the pleural cavity with the lung. Maurer coagulates by diathermy the tissues of the proposed line of incision in the parietal pleura about the base of an adhesion to seal all lymph and blood channels. Then by galvanocautery he cuts through the coagulated tissue and so proceeds to enucleate the adhesion. Since the coagulation by diathermy causes pain, the operative area is thoroughly injected with procaine by means of a long needle introduced through a cannula and guided under thoracoscopic vision.

Instruments: When one of us (I.A.S.) first began this work under the personal tutelage of Gustav Maurer and Roberts in 1936, Maurer's instruments were used. In subsequent experience we have not found it necessary to have the combined diathermy and galvanocautery administered through the same electrode and con-

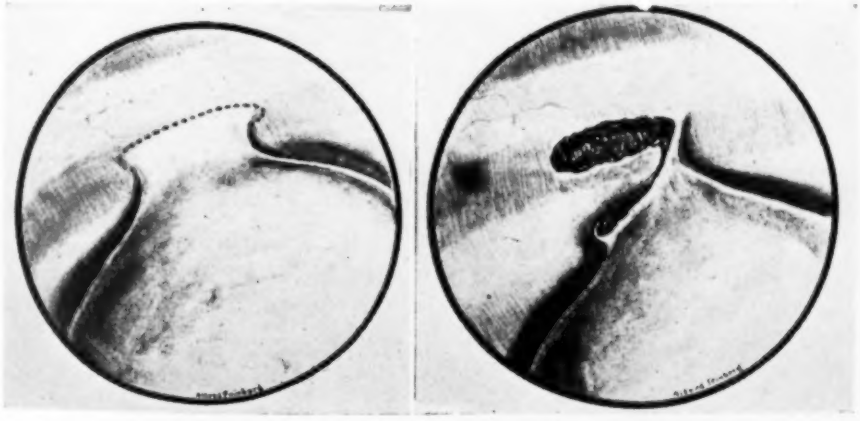

FIGURE 3a FIGURE 3b

Fig. 3a: Enucleation of the adhesion has almost been completed. Lung hanging from pleural sheet, which is still to be severed.—*Fig. 3b:* Illustrating the line of incision in the parietal pleura.

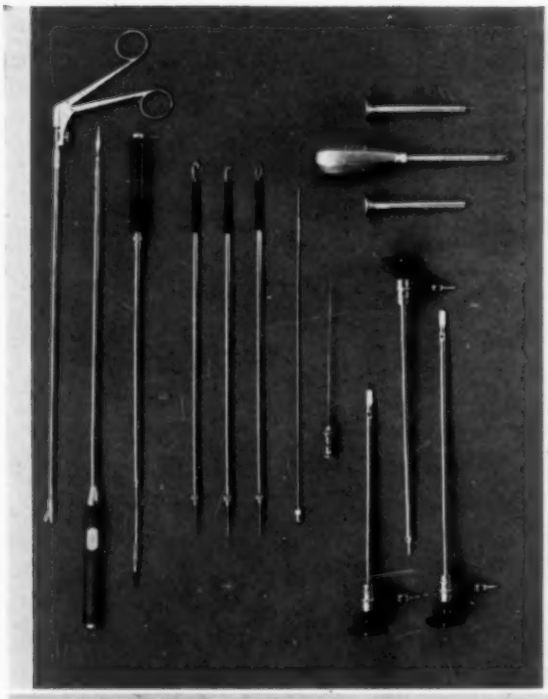

FIGURE 4b

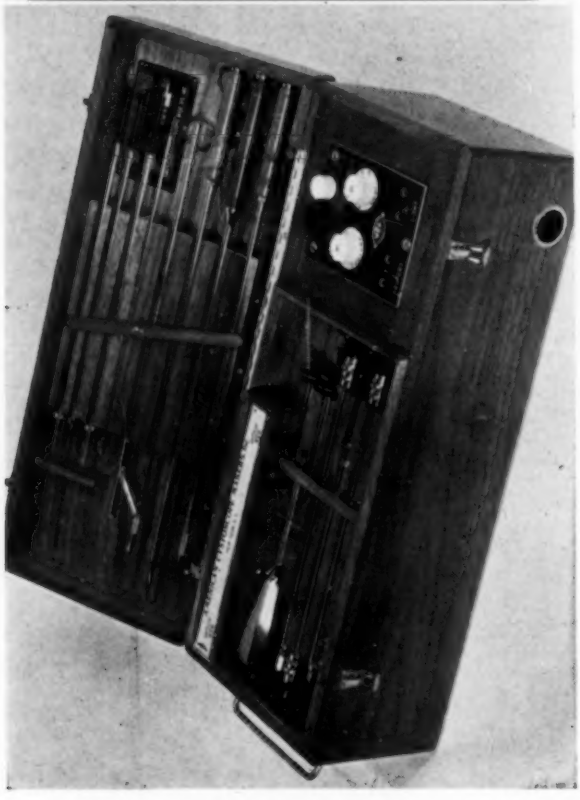

FIGURE 4a

Fig. 4a: The Thoracoscope in its case.
Fig. 4b: The individual instruments.

trolled by a double foot pedal, as designed and used by Maurer. We found that elimination of the diathermy lessened the pain of the operation and internal anesthesia usually was unnecessary. The elimination of the procaine solution at the base of the adhesion facilitated the cutting action of the galvanocautery tip and reduced charring of the tissues. We have never been troubled by bleeding from an adhesion stump and have had no difficulty in controlling by galvanocautery alone any flowing or spurting bleeding points in the chest wall. We prefer the galvanocautery because, with less equipment and expense, it satisfies all our requirements. Matson[19] particularly advocates the use of the high frequency current for cutting, but in addition to the pain associated with this modality, there may be difficulty in regulating the depth of coagulation of the tissue.

When Jacobeus first began to do closed pneumonolysis he used a telescope with right-angle vision through one cannula and introduced the cautery through another one. Following this, Herve (1915) and Mainini (1925) attempted the division of adhesions by means of a cautery introduced through one cannula and guided by fluoroscopic screening, but this was abandoned owing to the danger of uncontrollable hemorrhage and of section of the lung tissue with its sequelae of spontaneous pneumothorax and mixed empyema. In 1918, Morriston Davies suggested the use of a special tenotome which was inserted through the chest wall and the adhesion divided, under fluoroscopic control, by a sawing motion. This method has the same disadvantages as that of Herve.

In the meantime, various operators had suggested telescopes with various angles of vision and finally Davidson (1929), Chandler (1930), and Cutler (1932) devised "single puncture" instruments which carry the cautery and telescope through one somewhat larger cannula. We have used such instruments and have found that their relatively narrow range of movement and lack of flexibility have sharply limited what we were able to accomplish in cases with extensive adhesions.

We prefer a multiple puncture apparatus for several reasons:

First, it is more flexible than a single puncture instrument and adhesion systems can be examined from more than one aspect to decide whether or not they are operable and, if so, how best to proceed;

Second, the cautery and the telescope can be interchanged, when necessary, to afford greater manoeuvrability;

Third, if internal bleeding should occur and the stream of blood should cover the lens system of a single puncture instrument it is bound to be more difficult to control the bleeding than if the

telescope can be removed and reinserted through another puncture hole; and,

Fourth, we cannot subscribe to the desirability of limiting ourselves to just one puncture. In other types of surgery one never hesitates to extend an incision to facilitate the operation and we have never refrained from making two, three, four, or more punctures in the same patient if required to secure an adequate pneumonolysis.

Because of the need for clearer visualization of the operative field, special instruments were designed according to our specifications* which embodied the best features of all previously existing instruments and introduced several new ones[26] (Figures 4a and b).

One foroblique vision and two right-angle telescopes are available. The shorter right-angle telescope affords a wider field of vision with a lower magnification and is used for topographic study at the beginning of the operation and for photography. The longer telescope, affording higher magnification of a smaller field, is the so-called "operating" telescope. A correcting prism in the eyepiece yields an erect or non-reversed picture of the interior. This eliminates the difficulty experienced by some surgeons in the use of right-angle-vision telescopes which inverted the image so that the instruments would seem to move in the direction opposite to that intended. Each telescope is supplied with a particularly intense source of light fixed at a short distance from the lens opening. The lens systems are sharply focused and provide a relatively great depth of focus in the field of vision. All air-lens surfaces are "coated" to minimize light reflection and consequent loss of brilliance of the image. We have found these telescopes superior in the visibility which they afford.

Control of the cautery tips by a foot switch permits greater steadiness of the operator's hand. The three variously-shaped platinum tips are thin to minimize burned surfaces. Hook-tip cauteries are used when application of a straight tip is difficult —with them, lax adhesions may be drawn away from the mediastinum or lung into a safe position for cutting. An internal anesthesia needle is supplied, as are biopsy forceps and a suction tube. The suction tube has a guard distally to prevent injury to the lung and the proximal end is "Y" shaped to allow the use of a finger as a valve. A modified Maurer's hook with a finger-tip control in the handle is provided for use as an internal retractor. With it one may draw adhesions aside to see behind them and to investigate the thickness and the pleatings of an adhesion sheet. Two long, locking spongeholders are provided to carry bits of cotton

*By the American Cystoscope Makers, Inc., whose cooperation is greatly appreciated.

or dental roll for use in dissection in the chest wall cleavage plane or to apply pressure or hemostatics to a small bleeding point.

Technique of Operation and Enucleation: The lowermost level of the adhesions is determined before operation from roentgenograms and by fluoroscopy. More accurate localization is not necessary. We prefer to use the right-angle vision telescope through a cannula inserted posteriorly to the scapula in the sixth or seventh interspace (Figure 5). The posterior and lateral lung surfaces from apex to base, the paravertebral, posterior, lateral, and, frequently, a good deal of the anterior chest wall from the dome of the pleura to the diaphragm can be inspected easily from this position by rotating the telescope and changing somewhat the angle and depth of its insertion. Inasmuch as the vast majority of pleuropulmonary adhesions in tuberculosis occur over the upper posterior part of the lung (Diehl and Kremer),[10] this approach has been found to give the best field of vision for primary inspection and for the operative work (Figure 6). When necessary, the telescope also can be introduced through the anterior puncture which is usually placed in the third interspace in the posterior axillary line (Figure 5).

With the patient lying on his side and the scapula drawn well forward, skin and soft-tissue anesthesia is induced by injection of about 10 cc. of 1 per cent procaine containing 10 drops of 1-1000 adrenalin chloride to each 30 cc. of solution. The needle is inserted into the pneumothorax, as shown by withdrawal of a small amount

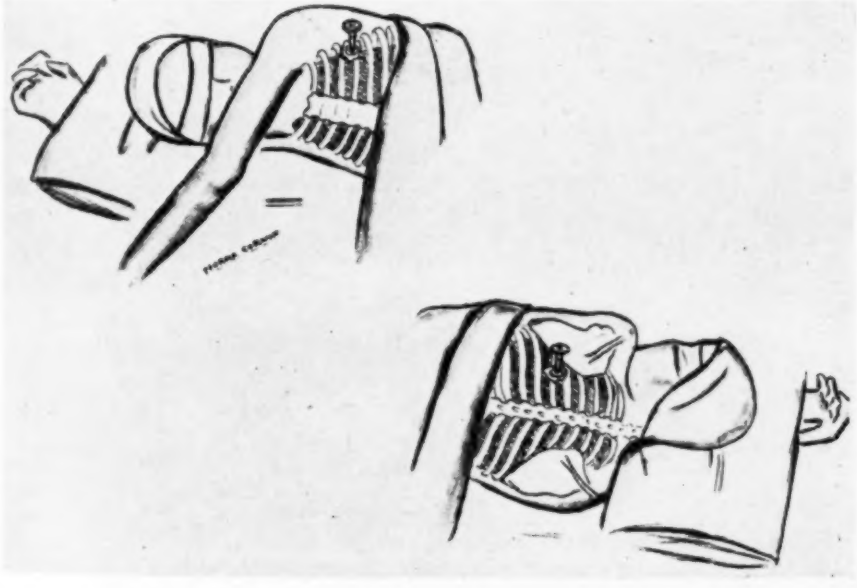

FIGURE 5: The usual sites for the insertion of the cannulae.

of air, and then the needle is withdrawn to deposit about 5 cc. to 10 cc. of solution just outside the parietal pleura.

A one-half inch incision is made in the skin and then a sounding needle is inserted (Figure 7) so that the tip just pierces the parietal pleura. The stylet, which is marked in centimeters beginning after the needle's length, is pushed gently into the chest. When it touches the lung surface, the distance from the parietal pleura may be read in centimeters on the shaft of the stylet. If the selected site is suitable for the introduction of the trocar and cannula, this

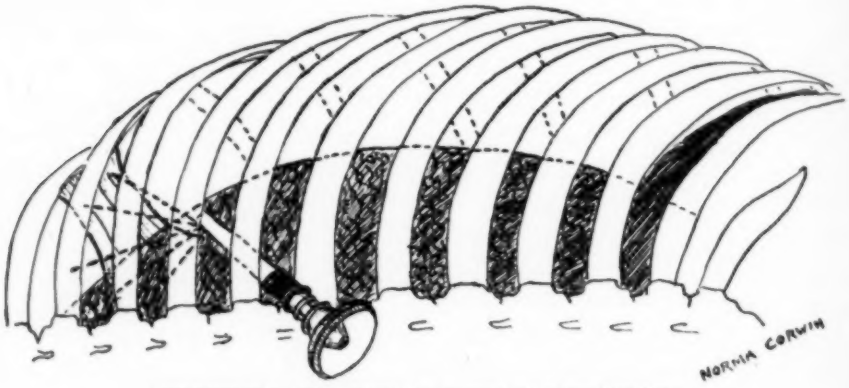

FIGURE 6: Showing the range of visualization.

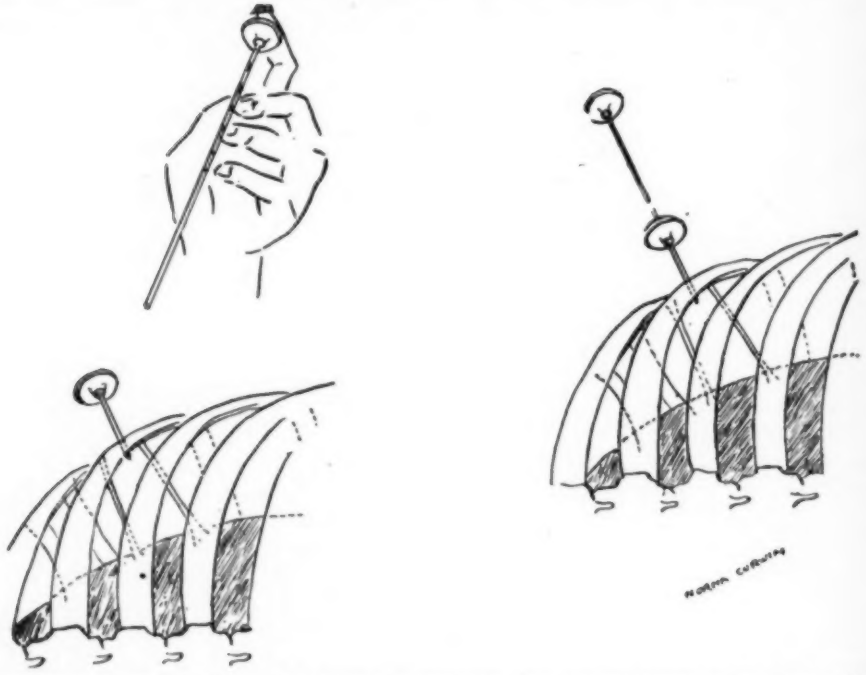

FIGURE 7: When the probe inserted through the needle touches the lung, the distance from the lung surface to the needle point at the parietal pleura will be shown in centimeters on its proximal part.

is done close to the lower rib with care to avoid damage to the vessels running along the inferior margin of the rib above. If, after the introduction of the cannula, the puncture site should prove to be in a place from which manipulation of the instruments is awkward or too difficult, the cannula should be withdrawn and reinserted at a more favorable site.

The pleural surfaces are inspected carefully and the location and extent of the adhesions determined. It may be necessary to divide minor adhesions before adequate inspection of the main adhesions can be made; only after several such divisions may it be possible to determine whether or not the major adhesions can be freed.

Each adhesion is transilluminated by a light placed behind it, as in Figure 8. That portion of the adhesion which does not contain lung will appear pinkish and translucent, whereas the lung-

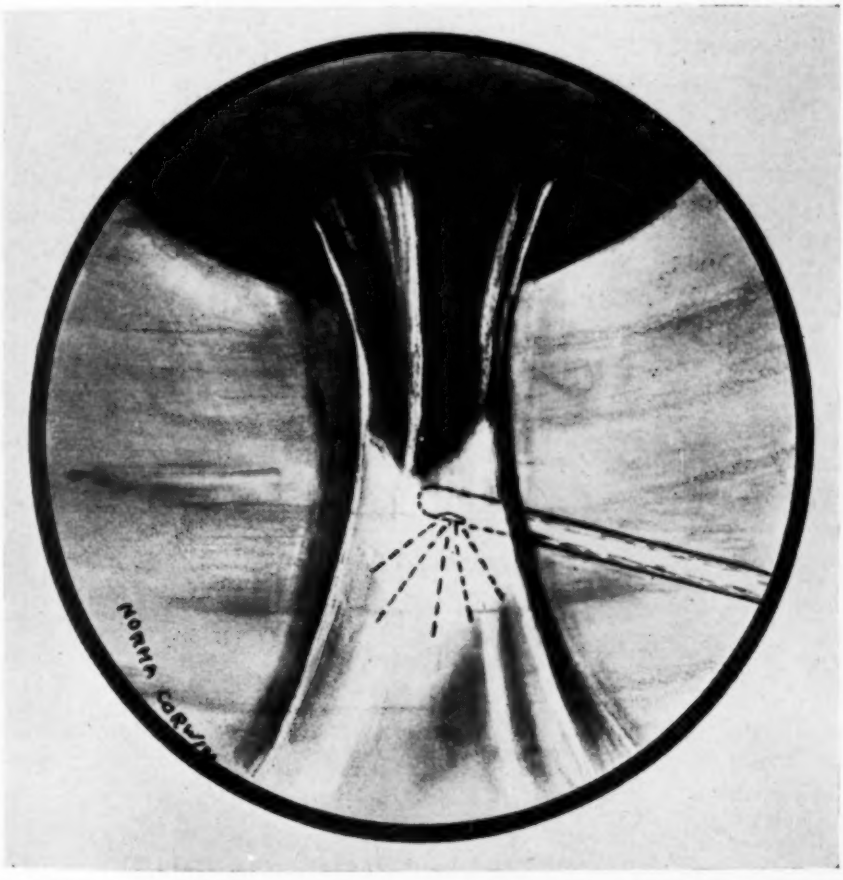

FIGURE 8: Transillumination using a lighted telescope behind the adhesion and an unlighted one for observation. The fibrous portion of the adhesion will appear pinkish and translucent. The lung-containing part will be darker and less translucent.

containing part will usually appear much darker and more opaque. It is important to know that a thin wedge or strand of lung may appear to be transilluminated if a bright light is used. *Consequently, we do not cut through any adhesion unless we can literally see through it.* If the adhesion cannot be sectioned we proceed to enucleate it at its chest wall attachment. The galvanocautery should be used at a dull red heat (as seen in the darkened room) to avoid rapid cutting and bleeding. The parietal pleura is incised by cautery a short distance from a fold of the adhesion insertion. As the pleura is incised the traction of the lung draws the adhesion from the chest wall and a cleavage plane becomes apparent in what is probably the endothoracic fascia. With the high-magnification telescope one can see clearly the fibrous strands of this tissue layer as the pleura is cut at the periphery of the adhesion and the extrapleural dissection proceeds by gentle stripping with a sponge or cold cautery tip.

Tougher strands of fibrous tissue may be cut by cautery. Bleeding points may be controlled by cautery or by pressure with a sponge soaked in adrenalin. Ordinarily there is no bleeding from the lung stump during an enucleation. If a vigorous bleeding point is encountered in the chest wall it is a mistake to attempt to control it by applying a hot cautery tip. This merely results in charring of the blood on the hot cautery. If the cautery is applied cold and the bleeding is stopped by pressure, then application of heat will act to seal the bleeding point. It may be necessary to repeat this manoeuvre several times.

Maurer advocates dissection in the intercostal muscles and rib periosteum when no extrapleural cleavage plane can be found. We did this quite frequently in our earlier cases but more recently have not forced the dissection if no cleavage plane is found. A cleavage plane may be lost momentarily, however, and then recovered by a flanking manoeuvre from another part of the adhesion. Braillon and others have described several cleavage planes in the tissues between the parietal pleura and the intercostal muscles and advocate separation in the outermost plane to avoid dissecting dangerously near the lung. Care should be taken to avoid pulling on the adhesions too vigorously during the stripping. Brock[6] believes this to be a cause of postoperative vomiting, which may cause trouble in management of the pneumothorax.

We have had occasion to observe these areas of the chest wall from which the lung has been enucleated at various intervals after the operation. Within 48 hours there seems to be present a thin covering-layer of glistening, transparent tissue.

As the dissection is carried in the extrapleural tissue, the parietal pleura is repeatedly incised at the edges until finally the

lung is suspended only by the remaining thin sheet of pleural attachment, which is then divided (Figure 9). If the enucleation has been extensive this pleural sheet may be so slack that the cautery tip cannot be applied to it. We have found it helpful to insert another cannula through which a spongeholder or Maurer's hook is used as a retractor to tense the adhesion and to draw it away from adjacent large vessels. It is then easy to cut across this remaining pleural sheet to accomplish the complete freeing.

If the enucleation has been so large that it becomes difficult to reach the field of operation another cannula may be inserted, at a higher level, to make the approach less awkward. If the final freeing can still not be accomplished, it is wiser to discontinue the operation and to wait several weeks, during which time the adhesion retracts and becomes tense again. The cannulae can then be inserted in a more favorable location. Occasionally a third or fourth stage may be necessary. We do not limit a sitting to any specific length of time since it is dangerous to cut the pleural and subpleural fibrous tissue and to leave the lung sus-

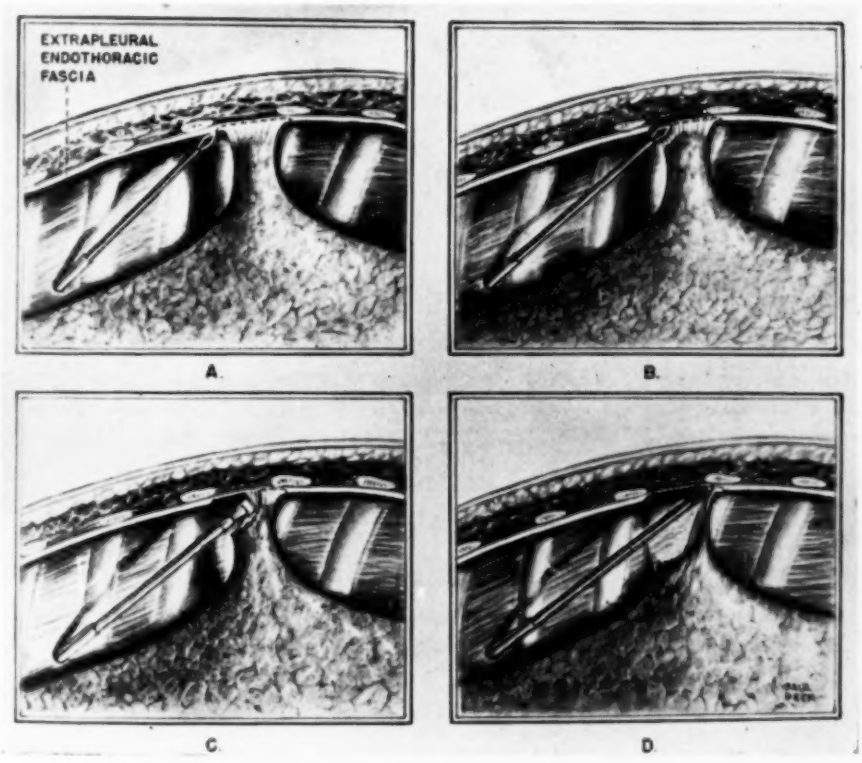

FIGURE 9: (A and B) The parietal pleura is incised by cautery a short distance from the adhesion.—(C) The cleavage plane is pursued by sponge dissection.—(D) The final sheet of parietal pleura after the adhesion has been dissected from the chest wall.

pended on the weakened central diseased core of the adhesion. This may lead to tearing of the lung and empyema. We prefer to prolong the individual operation until enough of the complex adhesion has been dissected from the chest wall to allow the lung to remain suspended from the fibrous sheet at the farther aspect of the adhesion until the next stage.

In a series of 101 cases operated upon by us at the House of Rest at Sprain Ridge, Yonkers, New York, during the past 10 years, the operative procedures were divided as follows:

TOTAL NUMBER OF PATIENTS	101
TOTAL OPERATIVE PROCEDURES	120
Thoracoscopy	7
Pneumonolysis,	
One stage	78
Two stages	13
Three stages	3

We believe that all adhesions that can be divided, should be, and do not attempt to cut so-called "key" adhesions only—we cut the adhesions first that are most accessible. Some surgeons advocate cutting all the fine adhesions first, believing that sudden tension on them after a large adhesion has been cut may lead to their tearing with consequent empyema. We have not seen this happen.

Adhesions may be so located as to render section dangerous. The most frequent site for such dangerous location is at the apex over the subclavian vessels. If the adhesions are long and can be determined by inspection and transillumination not to contain lung they may be cut across—preferably at least one centimeter from the vessels. If the adhesions are short and thick they cannot be cut but may be enucleated from this area. The incision through the parietal pleura and the establishment of the cleavage plane must be done at a good distance from the vessels—perhaps even at some distance from the adhesion. The pleural sheets must be stripped to be quite long so that their division by cautery may be done at least one centimeter from the vessels. It is at this point that it is very useful to insert another cannula through which a spongeholder may be used as a retractor. We have done many such apico-mediastinal enucleations, especially in bilateral cases, as has Braillon[4] and also Michetti (quoted by Braillon). Naturally a great deal of experience and exquisite care and patience are required in these cases.

Case 2: W.B. was admitted in September, 1940 (Figure 10a). Shortly thereafter a left therapeutic pneumothorax was induced and extensive apico-mediastinal adhesions were noted (Figure 10b). Six weeks later a

pneumonolysis was performed, during which an extensive apico-mediastinal extrapleural enucleation was done. After the lung and adhesion had been stripped from the region of the subclavian artery for several inches, the remaining mediastinal attachment was too lax to permit further division. The tension cavity (Figure 10c) closed slowly and in January, 1941, the mediastinal sheet adhesion, which had retracted, was cut in a second-stage pneumonolysis to permit final cavity closure. The sputum became negative in August, 1941 (Figure 10d), and the pneumothorax was continued uneventfully to voluntary abandonment in April, 1945. The lung reexpanded, with moderate pleural thickening (Figure 10e), and the patient has remained well and working.

We have not enucleated adhesions from the pericardium nor from the diaphragm.

The presence of a cavity, superficially placed and near the adhesion, is an indication for caution. Conant and Dale[8] advise against cutting adhesions in such cases because part of the blood supply to the outer wall of the cavity may come from the parietes through the adhesion. They believe that interference with the blood supply may cause necrosis of the cavity wall. If a cavitated area of the lung is directly adherent to the chest wall we would not attempt to do a pneumonolysis. But we have learned that roentgenograms may be misleading in the determination of the relationship of the cavity and the adhesion. Thoracoscopic examination may reveal that the cavity is actually separate from the parietal wall and the adhesion may be enucleated safely and easily.

"Tension" cavities are regarded by most surgeons as a contra-

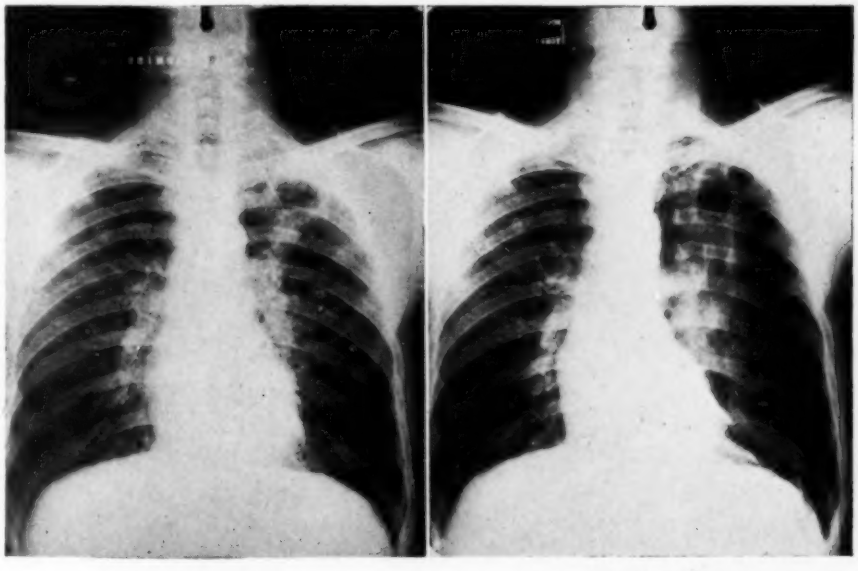

FIGURE 10a FIGURE 10b

Fig. 10a: Condition on admission, September 7, 1940.—*Fig. 10b:* Pneumothorax collapse hampered by extensive adhesions, October 5, 1940.

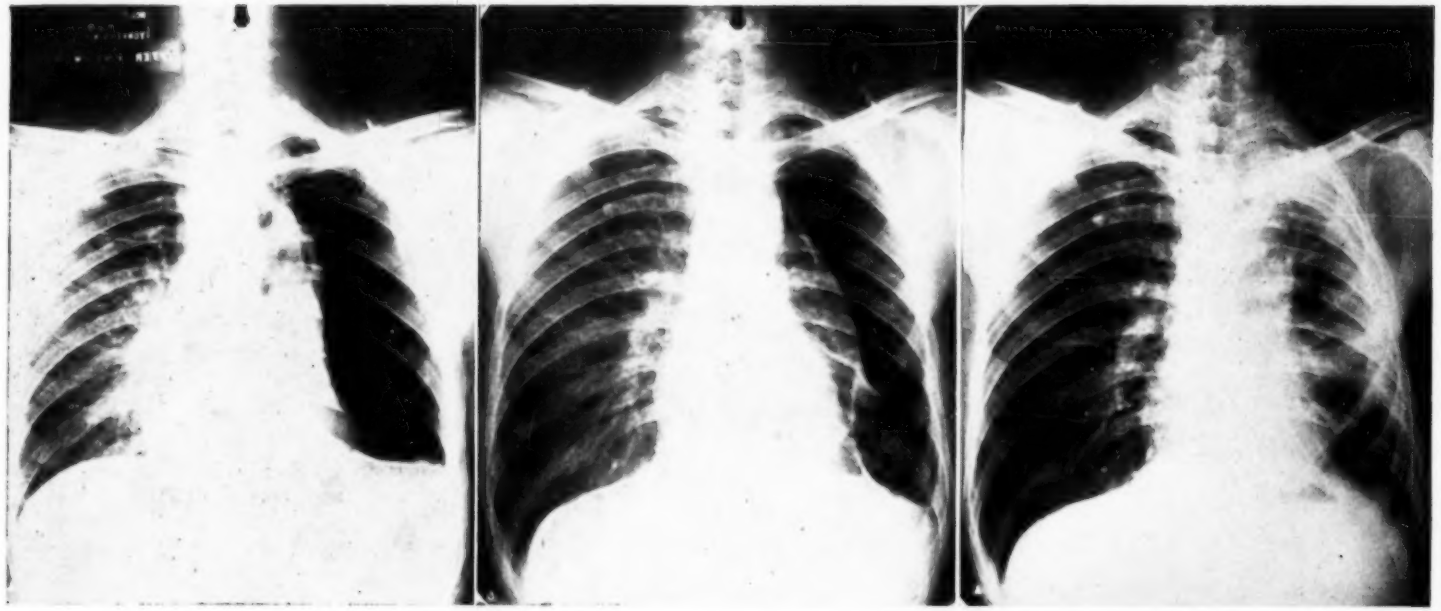

FIGURE 10c FIGURE 10d FIGURE 10e

Fig. 10c: After first stage pneumonolysis. Rounded cavity visible. October 19, 1940.

Fig. 10d: Cavity closed after second pneumonolysis. November 18, 1941.

Fig. 10e: Lung reexpanded. Patient well. August 10, 1948.

indication to pneumonolysis because, after release of the adhesion, unless the bronchus becomes completely occluded due to change in position and direction, the valvular mechanism in the bronchus may permit the cavity to balloon and possibly to rupture. The fact that a cavity is rounded in appearance, roentgenologically, is not sufficient basis for a diagnosis of tension cavity (Figure 10c). Also, many cavities may fluctuate in size without being true tension cavities. Our experience has been that more round cavities will close than will balloon after pneumonolysis.

Case 3: L.W., male, 23 years old, was admitted in January, 1940, with a small cavity in the apex of the right upper lobe and positive sputum. Right pneumothorax was induced promptly and, despite apical adhesions, the cavity closed and sputum became negative after three months.

In November, 1941, the sputum became positive again and a new cavity was found in the inferior lateral portion of the right upper lobe (Figure 11a). This rounded cavity fluctuated in size. The apical adhesions, although not over this cavity, were considered to be hindering the collapse. A closed pneumonolysis was performed (November, 1941) and several posterior apical adhesions were enucleated. The cavity fluctuated in size for several months, occasionally "ballooning" to a marked degree (Figure 11b), but finally closed in May, 1942, the sputum becoming negative for tubercle bacilli (Figure 11c). Subsequent cavitary disease in the left lung was treated successfully (1943-1947) by a pneumothorax uncomplicated by adhesions. The right pneumothorax was abandoned voluntarily and now both lungs are well reexpanded and the patient is a hard-working business executive (Figure 11d).

Inasmuch as tension cavities do not do too well under thoracoplasty and since resection can be done if a cavity balloons after pneumonolysis, we believe closed pneumonolysis should be undertaken in such cases.

The operability in each case depends on the experience, skill and judgment of the surgeon. The enucleation technique has widened greatly the scope of closed pneumonolysis. Nevertheless, in all cases in which an extensive enucleation (more than two to three inches in diameter) is necessary, the patient's clinical condition and the status of the contralateral lung must be carefully assessed. In unilateral cases it may be wiser to proceed with a thoracoplasty or excision.

Preoperative Preparation: The preoperative preparation consists largely of the pneumothorax therapy. It is unnecessary to push the pneumothorax to positive pressures in anticipation of the pneumonolysis and it is likewise unnecessary to give a large refill of air just prior to operation.

The chest and axilla are prepared as for any surgical procedure. For preoperative sedation we prefer to give three grains of a rapidly-acting barbiturate such as nembutal or seconal about two hours before the operation and then one-quarter grain of mor-

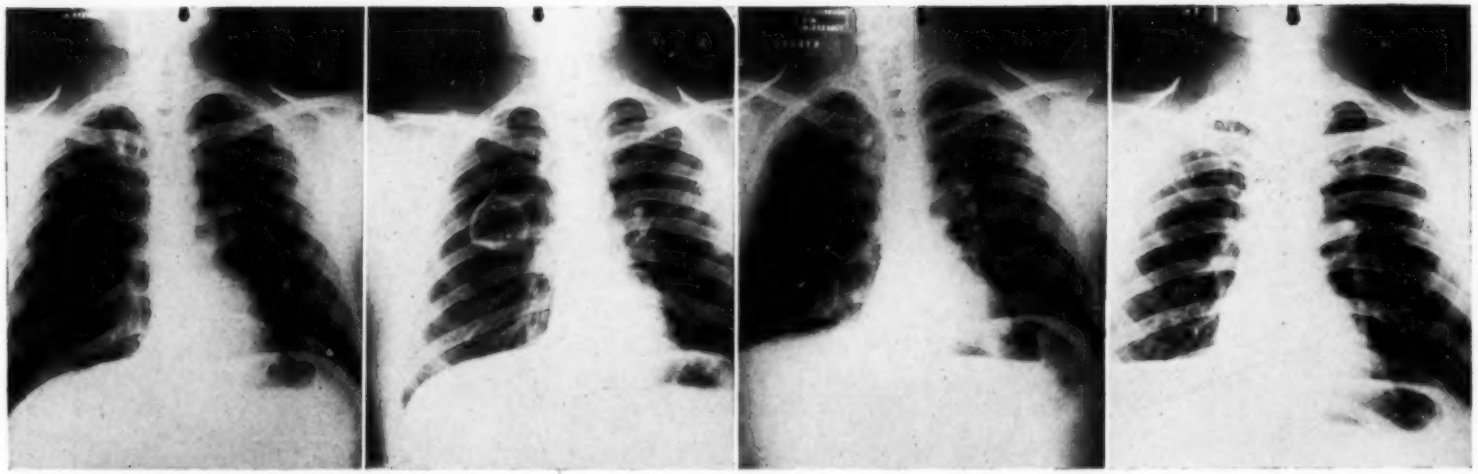

FIGURE 11a FIGURE 11b FIGURE 11c FIGURE 11d

Fig. 11a: Tension cavity, right upper lobe. November 15, 1941.—*Fig. 11b:* Cavity "ballooned." January 24. 1942.—*Fig. 11c:* Right lung well collapsed, tension cavity closed. Suspicious disease area in left upper lobe. March 22, 1943.—*Fig. 11d:* Both lungs reexpanded. Patient well.

phine and one-one hundred fiftieth of a grain of scopolamine or atropine about 30 to 40 minutes before operation.

Conduct of Operation: The operation should be done in a darkened operating room. Full surgical asepsis must be observed and a set of instruments for thoracotomy must have been prepared and be available at an instant's notice. No pneumonolysis should be undertaken unless at least one member of the operating staff is capable of immediately opening the chest surgically to stop bleeding if an accident should occur. Fortunately, such a need is rare. We have never yet had to do this. Alexander and others have described the occurrence of massive hemorrhages due to accidental damage to a large vessel. Thoracotomy must be prompt to save the patient's life.

The instruments should be boiled adequately except for the telescopes which are immersed for 20 to 30 minutes in a non-alcoholic antiseptic solution. Inasmuch as condensation will occur on a cold instrument when it is subjected to body temperature, a small basin of hot water should be provided on the instrument tray to warm the surface of the instrument before its introduction into the chest cavity.

Anesthesia: Local anesthesia is preferred for several reasons. Most anesthetists will hesitate to administer a general anesthetic when diathermy or cautery is to be used. Respirations and lung movement are more easily controlled with the patient awake. As the lung collapses when the adhesions are cut it is of great advantage if the patient can expectorate the accumulated secretions.

In addition to the skin and chest-wall infiltration with procaine, Maurer anesthetizes the chest wall internally about the adhesion and occasionally the intercostal nerves medially. With galvanocautery this is not usually necessary even when extensive enucleations are performed. The patient experiences more pain from the traction on an adhesion than from the heat of the cautery.

Position on Table: Special tables and positions are not necessary. We have come to prefer the insertion of an additional cannula and a retractor to attempts to shift the position of the lung and the course of the adhesion by posture. When the patient lies on his side, several folded sheets under the lower ribs will help to make the uppermost side convex and so widen the intercostal spaces. If telescopes of other than right-angle vision are employed, the patient must be positioned differently since the puncture sites will be differently located.

Dyspnea may be troublesome during the operation, especially in bilateral cases. If a pneumothorax needle (Saugmann) is inserted into the pleura through an intercostal space and gentle suction attached, the dyspnea will usually be relieved. Roberts

suggests the use of an aneroid pressure valve in the system to keep the suction pressure about −2 cm. of water.

Blood is an irritant to the pleura and at the conclusion of the operation it is our custom to aspirate all blood and clots and to lavage the pleural cavity with a liter of warm saline solution, which is then aspirated through the suction tube. The puncture holes are inspected from within the chest by the thoracoscope to determine whether any bleeding persists. We remove the anterior cannula first and watch the internal orifice of the puncture site carefully for a short time because, in our experience, most of the postoperative bleeding has come from this puncture. The intercostal vessels lie more exposed in the intercostal space anteriorly and are more likely to be damaged. On several occasions we have noted roentgen shadows on the anterior parietal pleura below the puncture hole and thoracoscopic examination has revealed these shadows to be due to blood clotting on the chest wall as it trickled from the puncture hole. If bleeding is seen when the cannula has been removed, we employ Overholt's manoeuvre[23] of dissecting a bit of muscle from the tissue about the incision and, after putting a catgut ligature about it, dropping this muscle plug through the re-introduced cannula. After the cannula is removed the second time the muscle plug is drawn up into the chest wall by the ligature and secured by tying the catgut over a cotton roll.

When the patient lies on his side the mediastinum swings toward the dependent side. If the cannula is extracted and the chest is closed while this condition exists, the mediastinum will tend to swing back to the mid-line when the patient changes position and the inordinately large amount of air trapped in the chest will cause a temporarily higher pleural pressure and lead to more marked postoperative subcutaneous emphysema. Therefore, the remaining cannula is removed during expiration.

The skin incisions are closed by silk sutures and a fairly tight compression dressing is applied to prevent, as much as possible, the escape of intrapleural air into the subcutaneous and subfascial planes of the chest wall.

Postoperative Care: Fluoroscopy is performed immediately after the operation and again the same evening if the operation has been done early in the day. The patient can usually sit up on a stretcher before the fluoroscope with little discomfort. If a refill or aspiration of air is seen to be required, the adjustment with final negative pressures is made at once. The patient is fluoroscoped and the pressures adjusted the next morning and then at least every other day until the pneumothorax is again stabilized. Failure to fluoroscope the patient frequently enough to observe fluid accumulation and the position of the lung may result

in loss of the pneumothorax by readherence of the lung. The lung should be kept well down for several weeks after pneumonolysis to permit complete retraction of the adhesion stumps.

Accumulated intrapleural fluid is aspirated promptly and at frequent intervals thereafter. Blood is a pleural irritant and aspiration of fluid is a safeguard against fibrin formation at the base causing reexpansion of the lung. Maurer, Diehl and Kremer, and Roberts, all stress the fact that the presence of blood in the pleural cavity seems to increase the incidence of tuberculous empyema.

The position of the patient in bed is important. Most surgeons keep the upper part of the body elevated to allow the fluid to gravitate to the base. In addition, we keep the patient lying on the unoperated side, almost prone, for at least 72 hours so that the lung may be kept as much as possible away from the operated area posteriorly. Of course, if the site of the operation has been anterior, the patient lies supine.

Sedation should be directed largely to suppressing violent cough. Pain is usually mild after pneumonolysis and the bad effect of interference with the cough reflex with retention of secretions must be borne in mind. Codeine in moderate doses is usually prescribed.

Patients who have previously been ambulatory are kept in bed until the pneumothorax is stabilized, fever has subsided and fluid has ceased to accumulate—generally about a week. If fluid accumulates and fever persists, especially if associated with evidences of beginning pleural thickening, the pneumothorax should, usually, be abandoned and rapid reexpansion of the lung encouraged. Oxygen lavages may be of help.

Despite complete anatomical collapse of the lung, cavities may fail to close because of thick walls that resist collapse, failure to obtain complete bronchial occlusion, or progressive excavation of the lung. If the cavity does not close after three, and certainly after six months, and if the case is otherwise suitable, a resection or thoracoplasty should usually be considered. If lobectomy or pneumonectomy is decided upon, the operation should be performed without abandoning the pneumothorax. We have seen severe spreads of the disease during the period of reexpansion of the lung. If thoracoplasty is decided upon, to obtain the best results the lung must be reexpanded completely, as soon as possible, before proceeding.

If the collapse by pneumothorax has been complete, or at least seemingly adequate, we have considered that thoracoplasty will not afford a greater degree of collapse and recently have preferred to proceed with resection. This is especially true in cases in which

the visceral pleura has become somewhat thickened so that complete reexpansion of the lung may be difficult, since the almost-universal experience has been that thoracoplasty over a partial pneumothorax has yielded relatively poor results in cavity closure. If lobectomy is performed, we can, if necessary, decorticate[29] the remaining lobe or lobes of the lung and favor rapid reexpansion by controlled suction intercostal drainage. Streptomycin is given during the immediate pre- and postoperative period.

Complications: The more common complications following closed pneumonolysis are surgical emphysema, hemorrhage, readherence of the lung, spontaneous pneumothorax, and empyema with or without bronchopleural fistula. Surgical emphysema occurs to a variable degree in almost every case but is not a serious complication in itself though it may be uncomfortable for the patient.

Hemorrhage may be a severe complication. The accumulation of blood or bloody fluid in amounts over 250 cc. which require several tappings should certainly be considered a hemorrhage. We have not seen bleeding from an adhesion stump; we have found that it usually comes from a cannula puncture site. It is important to know that when sizable bleeding occurs after pneumonolysis the clinical picture is that of shock from blood loss long before any evidences of tension pneumothorax appear. Even in cases of severe bleeding, thoracotomy usually fails to reveal the bleeding point. It is usually preferable to give supportive transfusions and to aspirate the pleural fluid as frequently as necessary.

Blood may clot in the pleura and lead to readherence of the lung. Occasionally it is desirable to thoracoscope the patient again to break up the clots with the suction tube and to aspirate them after lavaging the pleural cavity with warm saline solution. It may be possible by so doing to restore a good pneumothorax. However, bloody fluid in amounts large enough to require tapping may continue to appear for several weeks, slowly becoming clear and finally disappearing.

Readhesion of the lung to parietes, with loss of effective pulmonary collapse is an infrequent but serious complication of closed pneumonolysis. Maxwell[22] has pointed out three forms of this complication:

(1) The acute obliteration which usually develops within 48 hours of operation and is often total. It is generally considered a sequel to lung reexpansion as a result of massive escape of air from the pleural cavity in the presence of pleural changes that lead to rapid adherence of the visceral and parietal surfaces. Pulmonary emphysema, severe postoperative coughing or vomiting, and inadequate closure of trocar puncture sites are regarded as the chief causes of lung reexpansion.

Brantigan, et al,[5] have described cases which suggest that endobronchial tuberculosis may be a factor, by producing, after pneumonolysis, a check-valve type of bronchial obstruction that results in rapid reexpansion of the lung and loss of a pneumothorax space.

(2) Secondary obliteration occurs within a week or two of operation and tends to be more localized than the first variety, the sites of predilection being the posterior mediastinum, the paravertebral gutter, and the area of posterior chest wall between rib angles and posterior axillary line referred to endoscopically as the scapular zone. The occurrence of a readhesion of the lung is readily noted fluoroscopically. The lung is less mobile and there is usually a line suggestive of pleural thickening at the lung edge. This may be seen endoscopically to be a thin layer of blood clot. Divided adhesion surfaces alone or in conjunction with previously intact pleural surfaces may be involved. Faulty postoperative posture, inadequate control of the pneumothorax postoperatively, or a combination of both, are the important causal factors.

(3) Late obliteration is nearly always a sequel to postoperative effusion or to poor management of the pneumothorax with inadequate refills.

From the literature, Maxwell has found that acute reexpansion and readhesion of the lung (Classes 1 and 2) is reported to occur in about 1.3 per cent of cases, but, in addition, he comments that the great majority of cases are not recorded and that minor degrees of readhesion are not noted — as a consequence the condition seems much more rare than it actually is. It is stressed that careful attention to the details of postoperative care will usually prevent this complication.

Maxwell reported six cases in which prompt operative intervention reestablished a good pneumothorax collapse. In only one case, one in which pleural tuberculosis existed before "lysis," did tuberculous empyema supervene.

A small pleural effusion frequently occurs after pneumonolysis in at least one-half the cases. This, if of no consequence, clears up in a few days and is most likely due to the reaction of the pleura to the burn and to the blood. Occasionally, cases that develop simple effusions do not settle down but continue to have fever for some weeks; later the effusion becomes turbid and then a frank empyema. Goorwitch believes that the great majority of complications attributable to pneumonolysis occur in the first four weeks after operation. We customarily group as "postoperative" all pleural complications which occur within three months after the "lysis".

From the reports in the literature, the total incidence of empy-

emas (tuberculous and mixed) would seem to be from 10 to 25 per cent. This has not been our experience, nor that of Maurer or Brock. We believe this discrepancy is due to the fact that these surgeons prefer to enucleate adhesions. Brock reports that in 360 operations he incurred much or persistent fluid in 2.2 per cent, tuberculous empyema in 1.4 per cent, and mixed empyemas in 1.4 per cent, for a total of 5 per cent. Stettbacher (1947)[30] mentions that Maurer has operated upon 2000 cases. In his first 160 cases he incurred only two tuberculous empyemas. In the 85 cases operated during the time Stettbacher observed Maurer's work, the only complications were instances of slight transient fluids, and no empyemas nor hemorrhages. In our 10-year series at the House of Rest, the complications were as follows:

Complications in 120 Operations on 101 Patients

	Cases	Per cent
Serosanguinous fluid	17	16.8
Transient serous fluid	12	11.9
Purulent tuberculous fluid	5	4.9
Bronchopleural fistula	0	0
Mixed-infection empyema	0	0

Persistent clear effusions that complicated the pneumothorax are classed with purulent tuberculous fluids. Therefore, we believe that Maurer's enucleation technique not only increases the number of cases which can be operated successfully but also significantly reduces the incidence of empyema. In the five cases in this series with persistent tuberculous fluid, the lungs were promptly and rapidly reexpanded and the pleural space obliterated. Successful thoracoplasties were then performed. One of the worst mistakes in judgment, if the patient is fit to undergo further surgery, is the maintenance of pneumothorax complicated by tuberculous fluid following pneumonolysis.

If tuberculous empyema persists over a controlled lung, a thoracoplasty may be indicated, with or without preliminary thoracostomy drainage. Decortication, as advised by Gurd,[15] Lam,[18] and Curreri and Gale,[9] may aid in conserving functioning lung tissue and minimizing the amount of skeletal deformity by reducing the extent of the thoracoplasty required to obliterate the empyema space.

If tuberculous empyema persists over an uncontrolled lung, thoracoplasty may be indicated. Recent work indicates, however, that it may be preferable to proceed with lobectomy or segmental resection and decortication of the remaining lung, which is then encouraged to expand rapidly to obliterate the pleural space.[29] In early cases it may not be necessary to remove the parietal pleura.

Pneumonectomy may be required if the disease is not limited

to one lobe (or to two lobes of the right lung); or the interlobar fissure may be so firmly obliterated as to preclude lobectomy. Under these circumstances, an extrapleural pneumonectomy with total pleurectomy should be performed to eradicate en bloc the pulmonary and pleural disease.[28]

Streptomycin is given during the pre- and postoperative period parenterally and is injected after pneumonectomy and pleurectomy into the "pleural" cavity with buffered phosphate solution to control the pH of the medium.[28]

Spontaneous pneumothorax and mixed-infection empyema are usually the result of damage to the lung during operation or rupture of the wall of a ballooning cavity. Hitherto the accepted treatment has been aspiration of air and fluid by needle or closed intercostal drainage tube. In a small proportion of such cases the fistula closed spontaneously and the empyema could then be treated as a tuberculous one by aspirations and lung expansion. If the empyema persisted, thoracostomy drainage, thoracoplasty and Schedé resection of the parietal pleura were usually advised. However, this complication treated in this manner has been one of the greatest causes of death following pneumonolysis.

The accepted method of treatment in the future for this condition, if the status of the other lung permits, may be immediate resection of the diseased portion of the lung with associated antibiotic therapy. Lobectomy (or segmental resection) is the more desirable operation and we know of several cases treated successfully in this manner. Extrapleural pneumonectomy and total pleurectomy[28] will be required if the entire lung is diseased or if no interlobar fissure can be developed to permit lobectomy in otherwise suitable cases.

Results: It is usually estimated that from 40 to 50 per cent of pneumothorax failures are caused by adhesions. Matson found this to be true in 40 per cent of the 245 failures in his 1400 pneumothorax cases.

By the procedure of closed pneumonolysis, approximately 70 per cent (in our series, 71 per cent) of cases of pneumothorax unsatisfactory because of adhesions can be converted into a complete or satisfactory collapse with cavity closure and sputum conversion. It is of importance to note that the procedure carries with it practically no mortality. Also, many of the patients whose adhesions cannot be cut, and a good number of those who develop post-pneumonolysis complications, can still go on to thoracoplasty or an excisional procedure.

CONCLUSIONS

The indications, contraindications, complications and results of closed pneumonolysis have been discussed.

The technique of enucleating adhesions have been presented.

A series of cases from one sanatorium, operated during a period of ten years, has been the basis for this paper.

SUMMARY

Maurer's enucleation technique in closed pneumonolysis has rendered obsolete the classical Jacobeus method of dividing adhesions.

The enucleation technique has increased the scope of closed pneumonolysis while reducing the incidence of pleural complications.

RESUMEN Y CONCLUSIONES

La operación de enucleación de Mauer en la neumonolisis cerrada ha hecho anticuado el método clásico de Jacobeus de seccionar adherencias.

La técnica de enucleación ha extendido el campo de la neumonolisis cerrada y ha reducido la frecuencia de complicaciones pleurales.

1) Se han discutido las indicaciones, contraindicaciones, complicaciones y resultados de la neumonolisis cerrada.

2) Se ha presentado la técnica de enucleación de adherencias.

3) Se ha basado este trabajo en una serie de casos de un sanatorio, operados durante un período de diez años.

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Discussion

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The use of pneumonolysis has changed considerably over the past few years. We no longer feel it is necessary to resort to various and sundry methods which entail a considerable amount of intrapleural surgery. I have the feeling that a number of the individuals mentioned in this paper would have been better treated by thoracoplasty rather than by pneumonolysis. The latter procedure entails a considerable amount of work which, is not only dangerous to the patient but may also lead to a rather high number of intrapleural complications.

If we are to judge that all the cases in this series are of the type shown on the screen (which probably is not true), then I think we can say that of the five cases shown by Dr. Herben at least four would have been better treated by thoracoplasty. They had large cavities which were in the apex and relatively close

to the chest wall. That type of case is likely to get into trouble following pneumothorax and pneumonolysis, whether done by enucleation technic or whether the adhesions are long enough to allow relatively easy severence. We have come to discount that type of case entirely so far as pneumothorax and pneumonolysis are concerned. In disease of that type we have resorted to primary thoracoplasty. In these cases shown today, the contralateral lung was relatively good in all except one patient. Undoubtedly there were many others in the series in which that was not the case. However I feel certain that in these cases thoracoplasty would have given in the main a much better result.

The sputum conversion record in this group was 71 per cent. The sputum conversion record in well done thoracoplasty is much higher than that. In our recent series, it was between 87 and 90 per cent.

When one resorts to any type of extensive procedure to free adhesions from the chest wall, one is not advancing in surgery of tuberculosis but rather going back a good many years. The old records on pneumonolysis, especially Matson's work, show that he had many types of gadgets for such procedures. He did many operations to strip adhesions from the chest wall, and the results in those groups when finally analyzed were far from good.

In this series the record of fluid runs approximately one-third of the entire group. I think the essayist was fortunate in that only a relatively small number developed tuberculous empyema. In a group of pneumonolyses which we reported last year, of about 1000 cases, the percentage of fluid either transient or persistent was much lower than in the group presented. We must realize that the best treatment for the patient is the simplest operation, and the one which will get the patient well with the least amount of trouble.

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I have been exceedingly critical of this work, because while the end results here appear to be good, it seems that in less experienced hands much more harm could come from following such practices.

If intrapleural pneumonolysis were as simple a procedure as was illustrated on the slides we have seen this morning, and if the procedure could be carried out in a way similar to the manner in which it has been presented, I think we might agree with the essayist that these adhesions may be attacked. However, when you get into the pleural space and look through the thora-

coscope things do not look as simple as they did on these slides. One can never see the entire adhesion at one time; seldom can you go around the adhesion as they have demonstrated here. It is necessary as a rule to start at one side and work across the adhesion and the tissues behind the adhesion are not diagrammed as they are here. You cannot always see where the intercostal vessels are. And for that reason visibility in the thorax through the thorascope is somewhat difficult.

The results of the operative procedure are peculiarly unsuited to statistical analysis because of the many variables.

Beginning with the clinical material, the varying stages of disease; we find many wide variations in indications for pneumothorax itself. The different methods of handling pneumothorax, frequency of treatments, degree of collapse maintained in different hands — constant variables which are reflected in the end results of the operative procedure. Opinions as to how long after operation the development of tuberculous pleural infection can be attributed to the procedure, may vary. To me the operation is still suspect if a tuberculous empyema shows up within a year. Therefore we must all the more carefully individualize each case in recommending the procedure. Preoperative classification, which I find useful, divides the patients according to the urgency for pneumonolysis to be applied by the surgeon at the operating table. The first group, those in whom the procedure is feasible but not necessarily required for effective pneumothorax. If the thoracoscopic view suggests the slightest difficulty in cutting adhesions the operation should be abandoned. The second group are those for whom the operation is desirable, but not imperative. Here we encounter the ordinary risks of enucleation and proceed with the operation. The third group are those in whom we may consider the procedure necessary if any reasonable chance for the patient's recovery is to be entertained. These are patients with bilateral lesions, more extensive disease or larger cavities. One side must be brought under control in order to attack the other. This group may be classified as urgent.

The startling and unexpected development of possibilities of resection in tuberculosis has a bearing on the problem of how urgent it may be to cut adhesions. On the other hand, development of technic of decortication is on the other side of the ledger in determining the extent of the disease which may be attacked. In the unilateral case with a large cavity in the upper lobe it would be better to do a lobectomy than to take chances on large adhesions.

Two unusual complications in my series may be noteworthy; one was an air embolus due to an injury to the intercostal vein

which resulted fatally on the operating table; the second was a tuberculoma resulting in certain cerebral symptoms six weeks after operation and causing death in three months. Whether this was coincidental one cannot say.

Closing Remarks

Foster Herben, M.D., F.C.C.P., New York City: Perhaps I was unwise in omitting comment about mortality; in the 120 operative procedures enumerated this morning we encountered no moratlity. The percentage of sputum conversion which we attributed to the procedure alone was 71 per cent, which compares not too unfavorably with thoracoplasty.

I would not like to have the impression obtain that we utilize this procedure in preference to thoracoplasty, or that we are not aware of the value of thoracoplasty or excisional surgery. We do not regard this as a "fancy" procedure. Having it at our disposal, we have felt that in cases in which our best judgment indicated that we might expect success, it would be our duty to employ it. It stands to reason that there are cases not included in this group in which primary thoracoplasty or excisional surgery would obviously be the procedure of choice.

The chief purpose of presenting this paper to you is to illustrate what can be done without apparent detriment, and to show the results obtained in a small institution where, over about 10 years, a procedure has been employed without much change in its indications.

Pulmonary Resection in Tuberculosis
A Correlation of Clinical Indications and Pathology*

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St. Louis, Missouri

The purpose of this paper is to attempt to correlate the clinical indications for pulmonary resection with the gross and microscopic pathological findings of the removed specimens. The basis of our study is a series of 34 consecutive pulmonary resections for tuberculosis performed at the Missouri State Sanatorium between April 24, 1946 and December 31, 1947.

Recent advances in the fields of anesthesia, pathologic physiology of intra-thoracic organs, and improvements in surgical skill and technics have established the operation of pulmonary resection in tuberculosis as being not only feasible but an essential addition to our present knowledge for combating this disease. In the short space of eight years since the somewhat discouraging report of Dolley and Jones[1] (1940), there has been a steady decrease in mortality and complications of pulmonary resections in tuberculosis with a corresponding increase in satisfactory results. Among the factors responsible for the improved results are (1) the universal adoption of the individual ligation technic[2] and pleuralization of the bronchial stump; (2) improvements in the skill and technic of the surgeons and (3) improvements in anesthesia. To these may be added the use of streptomycin pre- and postoperatively. The reports following its use in the surgery of pulmonary tuberculosis have been encouraging.[3,4]

Most reports have been concerned primarily with the clinical indications for operation and the results of various series of cases. A presentation of the gross and microscopic examinations of the removed specimens has been absent with the exception of articles by Samson,[5] Kinsella,[6] Churchill and Klopstock,[7] Lorge and Du-

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fault,[8] and Overholt and Wilson.[9] Single case reports including pathologic findings have been presented by several authors.[10-12] Meissner,[13] by his study of the pathology of 60 pulmonary resections performed by Overholt, has given us a picture of endobronchial tuberculosis which has aided in clarifying some aspects of the problem of this type of pathology being an indication for pulmonary resection. Although our series of 34 cases is too small to permit definitive or dogmatic statements, further studies would undoubtedly lead to a uniform classification of the indications and contraindications for pulmonary resections.

We have tried to correlate the roentgenographic and clinical picture with the gross and microscopic findings. Bronchi were carefully dissected and many sections of both bronchi and individual lobes were made. Sections were stained by Hematoxylin and Eosin and also by Verhoeff Van Gieson methods. This latter stain is ideal for study of the lung as it selectively stains the blood vessels, outlines alveoli, and gives much more information than the conventional H and E stains.

Of our 34 resections, 25 were pneumonectomies and 9 lobectomies.

TABLE I

STATUS OF PATIENTS ON JANUARY 1, 1949

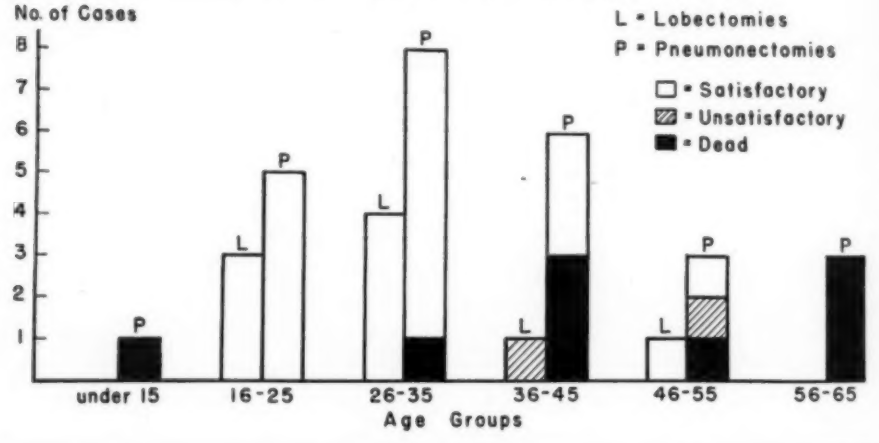


TABLE 2

Types of Operations

Left Pneumonectomy	14 cases (5 under thoracoplasty)
Left upper lobectomy	3 cases
Left lower lobectomy	2 cases (1 under thoracoplasty)
Right pneumonectomy	11 cases (4 under thoracoplasty)
Right upper lobectomy	2 cases (1 under thoracoplasty)
Right upper and middle lobectomy	1 case
Right middle and lower lobectomy	1 case (1 under thoracoplasty)
TOTAL	34 cases (12 under thoracoplasty)

A few pertinent statistics are presented in Tables 1 and 2. The youngest patient was a 10 year old colored boy who underwent pneumonectomy for a rapidly progressing caseous-pneumonic disease; the oldest was a 65 year old white female who had a residual cavity and bronchiectasis following thoracoplasty. Twelve of these cases had previous thoracoplasty on the side of the resection of whom three had contralateral pneumothoraces and one contralateral oleothorax. Another case without thoracoplasty had pneumothorax on the contralateral side.

Preoperative preparation: Electrocardiograms were obtained and in some exercise tests were performed in order to evaluate the cardiac reserve. Ideally, all patients who are candidates for excisional surgery should have respiratory function tests. Vital capacity and bronchospirometic studies are misleading; often giving the surgeon a false index as to the efficiency of the remaining pulmonary tissue. In the final analysis, life depends on the diffusion of oxygen and carbon dioxide through the pulmonary alveoli. Methods of determining ventilatory function and pulmonary diffusion have been described by Ornstein[14] and others, and thoracic surgeons are increasingly realizing the importance of these tests in selected cases. Although we are now contemplating the use of these tests, they were not utilized in the present series.

Contralateral pleural fixation and disease and contralateral collapse therapy obviously reduce respiratory function. Clinically we have found that contralateral pleural fixation, as the result of adhesions, re-expanded pneumothoraces and hydropneumothoraces, fibrosis from disease, and emphysema are the greatest offenders in diminishing the respiratory function.

The present series coincided with the increasing use of streptomycin pre- and postoperatively. Of the nine lobectomies, three patients received streptomycin beginning one to two weeks preoperatively for 120 days; four others received streptomycin in the late postoperatively period (after three months) for occasional positive sputa. Of these, three were converted to negative. Of the 25 pneumonectomy cases, three patients received streptomycin beginning six weeks preoperatively for 120 days for extensive tracheobronchial disease involving the stem bronchus where division was anticipated. The tracheobronchial disease healed rapidly and resection was then performed without complications. Seven others were given streptomycin during the immediate pre- and postoperative period.

Four pneumonectomy cases were given streptomycin after the third postoperative month; the indications being wound infection, genito-urinary tuberculosis, late reactivation in the remaining lung, and positive sputa after resection.

Anesthesia: All but two of the patients were operated under epidural anesthesia;[14] the remaining two received gas anesthesia (nitrous oxide) by facial mask. Postoperative bronchoscopic aspirations were not performed.

Technic of operation: All operations were performed with the patient in the anterolateral decubitus position. The posterolateral approach was used with individual ligation of the hilar structures, interrupted suture closure of the bronchial stump, and pleuralization of the hilar structures. Catheter drainage of the pleural cavity was utilized only in lobectomies in order to facilitate re-expansion of the remaining lobe or lobes. Nylon suture was used throughout. Between four and eight weeks postoperatively, a modified thoracoplasty was performed to obliterate the pleural space. In lower lobectomies, the space was obliterated by a phreniclasis performed at the time of the resection.

Postoperative regime: Oxygen was given routinely postoperatively. Water-sealed suction bottles were connected to the patients with thoracotomy tubes. Except for a period of approximately 10 days before post-resection thoracoplasty, all patients were strict bed-patients for three months following resection; then they were allowed to increase their activity gradually so that by the end of the fourth month they were allowed full lavatory and dining room privileges. They were placed on graduated exercises in the ninth or tenth postoperative month and were discharged as arrested cases in the twelfth or thirteenth postoperative month. Thus we were able to observe these patients for at least a year following surgery.

Mortality and Complications: There were nine (26.5 per cent) deaths in the entire series, all occurring in pneumonectomy patients. The corrected mortality rate would be 36 per cent for pneumonectomy cases and none for lobectomy cases. These deaths were arbitrarily classified as "Early" or "Late", 90 days being used as the dividing line. Under this classification, there were four early and five late deaths.

Of the four early deaths, two occurred within 24 hours. Autopsy of the first patient who had previous thoracoplasty revealed a cor pulmonale and edema of the remaining lung. This patient was 65 years old, and was treated for congestive heart failure one year prior to resection (Case 11 in text). The second patient died of an unfortunate operative accident, the contralateral main bronchus having been injured during the resection, a partial stenosis resulting from the repair, and death caused by respiratory insufficiency. The third patient died on the 17th postoperative day. She had a contralateral oleothorax and the pneumonectomy was performed under a thoracoplasty. This was also clinically a

respiratory insufficiency. The fourth patient died on the 64th postoperative day; however, it occurred only two weeks following the postpneumonectomy thoracoplasty (Case 4).

Of the five late deaths occurring after the arbitrary 90 day period, the first patient died six months postoperatively. This patient had a one-stage thoracoplasty with apicolysis nine years before and had a severe empyema with a broncho-pleuro-cutaneous fistula. Clinically, there was evidence of amyloidosis. There had been frequent attacks of hemoptysis and the resection was undertaken as a desperate life-saving resort. The patient developed a gradually increasing cardio-respiratory failure which was undoubtedly the cause of death. Autopsy was not obtainable. The second death occurred in the seventh postoperative month. This patient had previous thoracoplasty and developed symptoms and signs of cardiac failure three months after operation plus a broncho-pleural fistula and empyema in the fifth postoperative month. Autopsy confirmed the clinical picture. The third late death occurred in the eighth postoperative month. This 62 year old male developed a wound infection, empyema and a large bronchocutaneous fistula. The fourth death was in the 10 year old colored boy who had extensive caseous-pneumonic disease for which pneumonectomy was performed. Infiltration occurred in the contralateral lung in the eighth postoperative month and he died the following month (Case 12). The last death was in a 64 year old white female, who died one year postoperatively of a nontuberculous bronchopneumonia, confirmed at autopsy.

Two patients developed early postoperative spread of disease. Discounting the two early deaths occurring within the first 24 hours, this is an incidence of 6.2 per cent. There was only one early postoperative spread among those having epidural anesthesia—an incidence of 3.3 per cent. Spreading of a tuberculous process in the lungs during surgery is the result of spilling of infected sputa into previously uninvolved areas of the lungs. Streptomycin materially decreases the volume of sputum and number of bacteria resulting in lowering the incidence and gravity of spreads. However, we believe that epidural anesthesia is further responsible for decreasing the incidence of spreads as the patients are conscious, cooperative, and able to cough and expectorate throughout the operative procedure. Both of the patients with early spreads had extensive active endobronchial tuberculosis; one of these is presented in the text (Case 3). The spread in the second patient was controlled by further thoracoplasty and she has been discharged as an arrested case.

Four patients developed new infiltrations in the seventh to tenth postoperative months. One with apical thoracoplasty and

contralateral pneumothorax who had upper lobectomy under the thoracoplasty developed a new infiltration in the remaining lower lobe with a positive sputum in the seventh postoperative month. The lesion is clearing under rest and streptomycin regime and sputa have been negative the past three months. The 10 year old colored boy developed contralateral disease in the eighth postoperative month and expired shortly after. Two patients developed contralateral circumscribed lesions in the tenth postoperative month with positive sputa. The lesions disappeared under rest and streptomycin, and sputa were converted to negative.

There were four cases with bronchopleural fistulae (12.5 per cent). Of these, one was temporary and not associated with empyema. Two patients had persistent fistulae with empyema developing in the second and fifth postoperative months. The fourth developed intermittent bronchopleural fistula and empyema in the 14th postoperative month. This patient was in the hospital for genito-urinary tuberculosis. The incidence of empyema was 9.4 per cent. There were three cases with wound infections (9.4 per cent). One of them had empyema and died. The other two recovered.

Present Status of Patients: Of the nine lobectomy patients, five are now classified as arrested and have been discharged; two are quiescent with negative sputa; one who had previous thoracoplasty is now quiescent with an occasionally positive sputum. During the resection, the upper lobe which was the site of the major pathology could not be removed because of technical difficulties, and the source of the occasional positive sputum is thought to be from this remaining lobe. The last patient left the sanatorium in the fifth postoperative month and the status of her sputum is unknown; however, 27 months postoperatively she was radiologically negative.

Of the 16 living patients with pneumonectomies, 10 have been discharged as arrested; one is now on exercise preparatory to discharge; four are quiescent with negative sputa, and one is quiescent with positive sputum. This last case had contralateral pneumothorax which had to be re-expanded due to respiratory insufficiency. The source of the positive sputa is from this re-expanded lung. Table 3 illustrates the status of these patients at three month intervals.

Clinical Indications for Resections

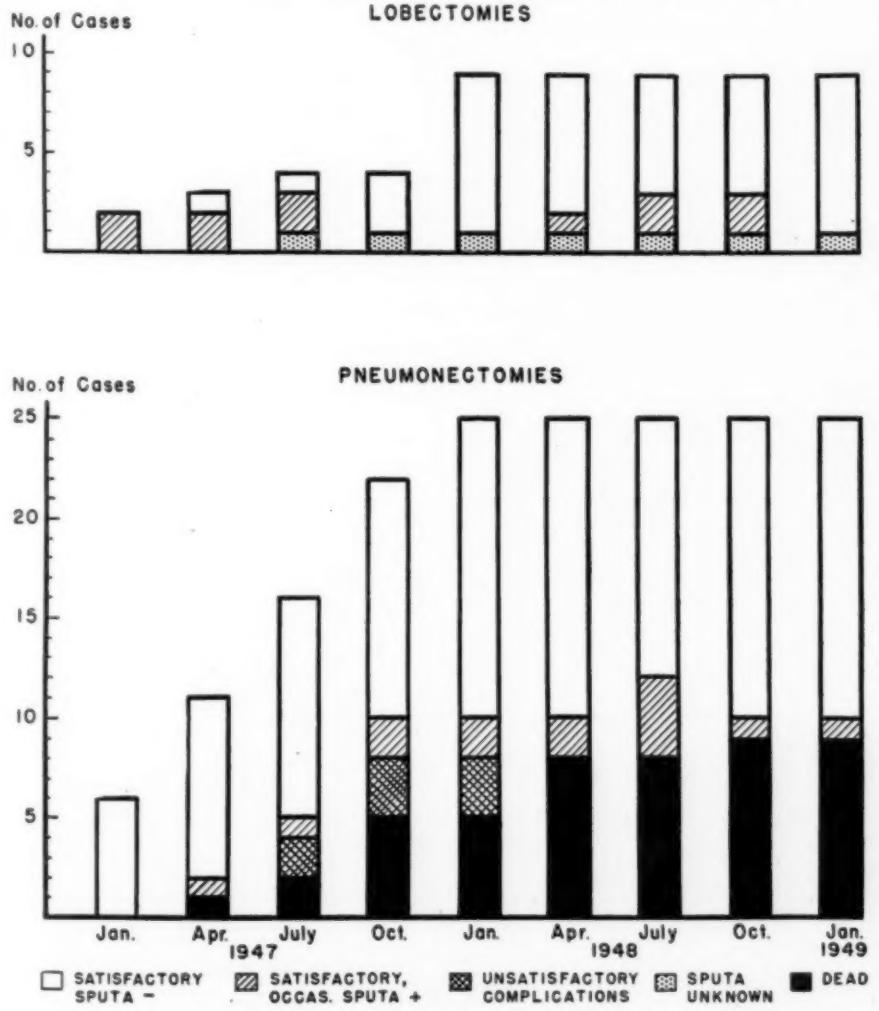
In an attempt to simplify the indications for resection in our series, we have classified the cases under five primary headings as shown in Table 4.

In addition, there were two cases thought to be nontuberculous but which on pathologic examination proved to be tuberculous,

making a total of 34 resections. We emphasize that these were the clinical indications and not the pathologic diagnoses; being based mainly on radiographic, bronchographic, and laboratory evidence. These indications are not as clear-cut as Table 4 would seem to imply. Most of these cases had several associated conditions which in themselves have been listed as proper indications by many authors. We have attempted to reduce the indications to their lowest common denominator. For example, in Group I, there were thre cases with previous thoracoplasties and associated tuber' ulous bronchiectasis. However, as the lesions for which the thoracoplasties had been performed were radiologically apparently

TABLE III

STATUS OF CASES AT QUARTERLY INTERVALS



controlled, these cases were not classified under "Thoracoplasty Failures." In the same group, the two cases that did not have previous thoracoplasty or bronchographic evidence of bronchiectasis were pneumothorax failures. One of these developed massive atelectasis of the upper lobe with continuing positive sputa and the other developed tuberculous empyema, atelectasis, and suppuration of the lung. Thus we find there is considerable overlapping of indications, but all of these cases had high grade bronchial stenosis which was considered the primary indication for resection.

A breakdown of these primary indications is presented in outline form in Table 5 in order that the associated conditions may be better realized. Many authors have listed tuberculous bronchiectasis (Group II) as an indication for resection. The term has been

TABLE 4

Group I:	Bronchostenosis	5 cases
Group II:	Tuberculous Bronchiectasis	22 cases
Group III:	Destroyed Lung with Cavitation	1 case
Group IV:	Lower Lobe Cavities	2 cases
Group V:	Thoracoplasty Failures	2 cases
	TOTAL	32 cases

TABLE 5

Clinical Indications for Resection

	No. of Cases
I. *Bronchostenosis with Endobronchial Tuberculosis:*	
A. Tuberculous bronchiectasis, previous thoracoplasty	3
B. Pneumothorax failure,	
1. Tuberculous empyema, atelectasis, suppuration	1
2. Atelectasis, U. L.	1
II. *Tuberculous Bronchiectasis:*	
A. Without Cavitation	4
1. Atelectasis and fibrosis	3
2. Previous thoracoplasties,	
a. Without empyema or B-C fistula	5
b. With empyema and B-C fistula	2
3. Pneumothorax failure	1
B. With Cavitation,	
1. Without atelectasis	4
2. With atelectasis and fibrosis	3
III. *Destroyed Lung with Cavitation*	1
IV. *Lower Lobe Cavity:*	
A. With tuberculous Bronchiectasis	1
B. Phrenic and pneumoperitoneum failure	1
V. *Thoracoplasty Failure:*	
Residual cavity and bronchiectasis	2
TOTAL	32

(In 2 additional cases, resections performed for other conditions proved on pathologic examination to be tuberculous.)

rather loosely applied in our series, patients having positive sputa and evidence of bronchiectasis being listed in this category. Our studies have led us to believe that this diagnosis is not easy to establish preoperatively and the condition is not as common as Table 4 would lead us to believe. A more thorough discussion of this subject will follow in the text.

All but four of these patients had positive sputa at the time of surgery. Two of the 22 tuberculous bronchiectasis patients were negative. One of them had extensive bronchiectasis and fibrosis with marked contraction of the affected lung; however, she had frequent small hemoptyses up to the time of surgery. The second patient had had negative sputa for 32 months, but during trial exercise she also had several hemoptyses. The third negative sputum patient was a 64 year old white female who was thought to have malignancy. The fourth patient was the 10 year old colored boy with extensive caseous-pneumonic disease involving the entire right lung (these last two cases make up the misdiagnosed group). His sputa were repeatedly negative and this diagnosis was not established until the pleural cavity was entered and caseous involvement of the mediastinal and hilar lymph nodes were found. There was no radiographic evidence of involvement in the contralateral lung so the decision to proceed with the resection was made at that time.

Tuberculomas and tension cavities are generally accepted indications for resection, but we had no cases of this type in our series. The preoperative diagnosis of tuberculoma is difficult to establish. Most cases of solitary circumscribed lesions are actually cavities filled with caseous material and tubercle bacilli.[16] Some of these lesions excavate and refill intermittently. This type of lesion is suitable for resection as its thick walls usually withstand collapse therapy, and it is potentially dangerous as a source of tubercle bacilli. We have removed these "putty tubercles" on two occasions (one prior to and one subsequent to our series) and found rather thick cavity walls filled with caseous material and tubercle bacilli. More often, a solitary circumscribed lesion is removed with a preoperative diagnosis of "Possible Neoplasm."

The management of tension cavities has been revolutionized since the introduction of streptomycin. These cavities are always due to a valve mechanism in the draining bronchus, and in most cases, endobronchial tuberculosis is the responsible factor. In our institution, tension cavities are an indication for streptomycin therapy. We have seen these cavities reduced to a fraction of their previous sizes during a course of streptomycin, and in many instances, have subsequently treated them by collapse therapy. In this respect, we are not in complete accord with Maier,[17] who

states that in some cases, "thoracoplasty without streptomycin is indicated. . . . The streptomycin should be reserved for the time of resection if the latter procedure is required."

Group I — Bronchostenosis

The studies of Samson,[18] Wilson,[19] and others have shown that fibro-stenosis of the bronchus in a tuberculous patient is the end result of an extensive tuberculous ulcerative bronchitis. Samson[5] was actually able to follow one case bronchoscopically from the ulcerative to the fibrostenotic stage. Apparently, the more destruction there is of the wall of a bronchus, the more extensive the resultant scar and stenosis will be. Auerbach[20] described these ulcerations as being lenticular; that is, their long axes are at right angles to the long axis of the bronchus. This probably contributes to the circumferential character of the stenoses.

Bronchostenosis is probably the most widely accepted indication for resection in pulmonary tuberculosis. Several surgeons, among them Baily,[21] O'Brien,[22] Alexander,[23] Brewer, Dolley and Jones,[24] qualify this indication by stating that only in high grade stenosis with symptoms of retention is resection preferable to thoracoplasty, primarily because of the lower mortality and morbidity associated with the latter procedure. Many of these authors prefer thoracoplasty in cases with moderate bronchostenosis without associated bronchiectasis or suppuration, even dilating the strictures between stages of thoracoplasty if indicated.

The question arises as to how often bronchial stenosis can be present without associated suppurative or bronchiectatic complications; and if none are present at the time of operation, how long will it be before they develop, even with apparently satisfactory control of the parenchymal disease. Studies have shown that various stages of endobronchial tuberculosis can be present within the same bronchus draining an active parenchymal focus, so that it is entirely possible to have various stages of active endobronchial tuberculosis distal to the stenosis. Also, once the endobronchial disease becomes established, it can and does progress independently of the parenchymal focus.[19] The two most common etiologic factors in the development of bronchiectasis, namely infection and obstruction, are present in cases of endobronchial tuberculosis with stenosis.

I. Bronchostenosis

A. *Tuberculous Bronchiectasis and Previous Thoracoplasty*

There were three cases in this group. All of whom had positive sputa, previous thoracoplasties, and bronchographic evidence of bronchiectasis distal to their stenoses.

Case 1: (17668-41) V.C., white female, age 25, duration of disease 5½ years. Patient was first admitted June 29, 1942 with far advanced disease and positive sputum. In July 1942, a left pneumothorax was instituted but abandoned, as it resulted in "ballooning" of the cavity (Fig. 1a). Left phrenemphraxis was performed in December 1942, followed by three stages of posterior and one stage of anterior thoracoplasty between January and May 1943. This resulted in sputum conversion and subsequent discharge as an arrested case in October 1944 (Fig. 1b, after completion of thoracoplasty). She was apparently in good health until December 1945, when she developed acute respiratory infection and positive sputa.

The patient was re-admitted in June 1946. Bronchoscopy revealed extensive granulation tissue and ulceration about the left main stem bronchus (which was almost completely occluded) extending up the posterior and lateral wall of the trachea. Repeated bronchoscopic treatments with 30 per cent silver nitrate resulted in only slight improvement of the endobronchial pathology. Streptomycin[25] was administered from February 27, 1947 until June 27, 1947, a dosage of one gram daily for one week followed by 0.5 gm. daily thereafter in two divided doses being employed. Within four weeks after the institution of this therapy, the extensive endobronchial lesion completely cleared, leaving a clean, high grade bronchial stricture just below the carina in the left main bronchus (Fig. 1c, preoperative bronchogram demonstrating the stricture and the bronchiectasis). Left pneumonectomy was performed on April 15, 1947 approximately seven weeks after institution of streptomycin therapy.

The pneumonectomy specimen showed numerous fibrous adhesions over the surface of the upper lobe. The lymph nodes at the hilum were not remarkable. On section there was a questionable thin-walled collapsed cavity at the apex. Rather prominent bronchiectasis was found in the region of this cavity with evident increased fibrosis around the bronchi. The microscopic sections showed little active disease. The apex demonstrated secondary bronchiectasis with a few rare submucosal tubercles. Rather prominent hypertrophy of the muscularis mucosa of the bronchi leading to the upper lobe was present. The point of stricture in the main bronchus was not included in the resection. The microscopic diagnosis was: encapsulated caseous foci and bronchiectasis, predominantly non-specific, with occasional submucosal tubercles.

Postoperative course was uneventful. Sputa remained negative and the patient was discharged one year later as an arrested case (Fig. 1d).

Comment: The other two cases in this group were quite similar preoperatively, having apparently satisfactory thoracoplastic collapses without sputum conversion. The second case, a 33 year old colored girl, also received streptomycin pre- and postoperatively. The pathologic specimen also showed encapsulated caseous foci and predominantly non-specific bronchiectasis. Although this patient had a high grade bronchial stenosis, there were no symptoms of secondary suppuration or infection. This type of pathologic process, however, seems to us to be an ideal indication for pneumonectomy with eradication of a non-functioning lung which remains a focus of positive sputum. In the third case, streptomycin was not given preoperatively. Pneumonectomy was attempted, but

FIGURE 1a FIGURE 1b FIGURE 1c FIGURE 1d

Fig. 1a, 7-10-42: Note large cavity at apex which ballooned out following institution of pneumothorax.—*Fig. 1b, 8-11-43:* Three stage posterior and one stage anterior thoracoplasty completed.—*Fig. 1c, 2-11-47:* Lipiodol demonstrates bronchiectasis and bronchial stricture.—*Fig. 1d, 7-19-48:* Postpneumonectomy film (15 months).

due to technical difficulties, only the lower and middle lobes were removed. This specimen contained acinous and acinous nodose foci and fibrosis in addition to the encapsulated caseous foci. Within the ectatic bronchi, there was extensive tuberculous involvement of the medium and small bronchi. The hilar lymph nodes were also involved with tuberculosis (Fig. 2). We felt that the pathologic findings in this case justified the removal of these lobes. However, the major pathology in the beginning was in the upper lobe which originally was atelectatic and contained a cavity. This lobe was left behind. As the contralateral lung was radiologically negative and as the bronchial stump was healed, it is highly probable that the occasional positive sputum this patient developed one year after resection was coming from the remaining lobe or its bronchi.

In case 1, streptomycin produced a marked change in the visible endobronchial disease, and the pathologic specimen revealed practically no active disease in the parenchyma or bronchi.

Mild to moderate endobronchial disease that responds to streptomycin therapy is per se not an indication for resection, as other forms of collapse therapy may suffice in arresting the disease process. In healing severe endobronchial disease with streptomycin, varying degrees of cicatrization and stenosis will occur. Such

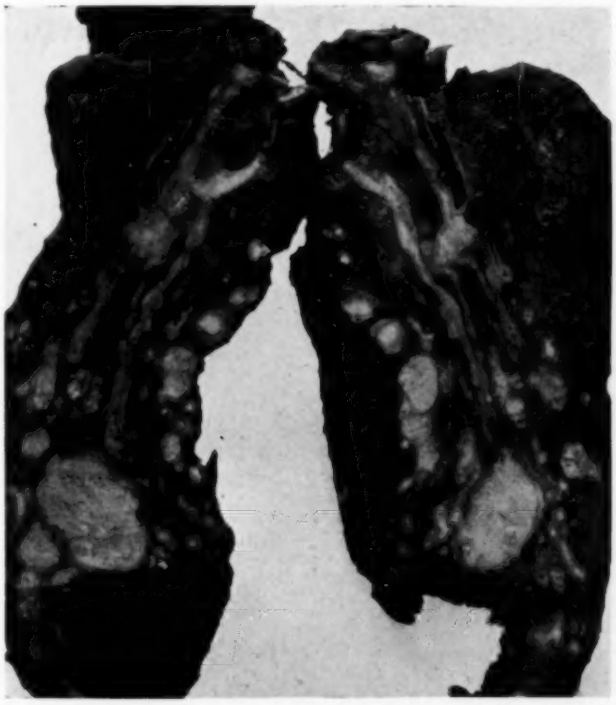


FIGURE 2: Pneumonectomy specimen. Note complete collapse of the lung with encapsulated caseous foci and bronchiectasis.

FIGURE 3a FIGURE 3b FIGURE 3c FIGURE 3d

Fig. 3a, 8-2-43: Note soft infiltration in left apex.—*Fig. 3b, 4-9-45:* Ineffective pneumothorax with deviation of the mediastinum to the left.—*Fig. 3c, 11-9-45:* Collapsed lung, left, with high diaphragm due to phrenemphraxis.—*Fig. 3d, 12-1-47:* Six months post-pneumonectomy.

stenoses will lead to pulmonary suppuration and bronchiectasis, which in themselves are indications for resection. As in case 1 above, streptomycin is now converting cases formerly considered unsuitable for surgery into suitable risks by lowering the operative risk and decreasing operative morbidity and mortality.

B. *Pneumothorax Failure*

There were two patients in this subgroup, both having high grade bronchial stenoses. Pneumothorax was instituted in both cases with varying consequences. In case 2 presented below, atelectasis and suppuration of the lung and tuberculous empyema occurred. In the second case, atelectasis of the upper lobe resulted immediately after institution of the pneumothorax.

Case 2: (16374-61) R.L.V. White female, age 45; duration of disease five years. Onset was accompanied by laryngeal symptoms in October 1942. She entered the Missouri State Sanatorium in July 1943, but left against medical advice three months later (Fig. 3a). While at home, symptoms became worse so she re-entered in April 1944. X-ray on second admission showed considerable progression of the disease in the left lung with multiple areas of rarefaction throughout.

Left pneumothorax was instituted on April 20, 1944. Closed intrapleural pneumonolysis was attempted in May 1944, but the adhesions could not be cut. The pneumothorax was re-expanded and a left phrenempharaxis was performed on June 7, 1944, resulting in a marked rise of this hemidiaphragm. The patient continued to be quite toxic with wheezing and severe cough. Bronchoscopic examination January 12, 1945 revealed extensive endobronchial disease about the left main stem bronchus which was completely obstructed with granulation tissue. The area was cauterized repeatedly with 30 per cent silver nitrate at four to six week intervals with slight improvement. (Fig. 3b shows status of lungs on April 9, 1945). In June 1945, she developed empyema in the left chest which proved to be tuberculous. This was treated semi-weekly by aspiration, irrigation, and instillation of Azo-chloramide with tetradecyl sulfate. The empyema cleared and became bacteriologically negative by October 1945. Left pneumonectomy was considered at this time but the active endobronchial disease in the main-stem bronchus at the level of the carina seemed to contraindicate operation. (Fig. 3c, taken November 9, 1945. Negative pressure was adjusted to −36 cm. of water after each aspiration with no further re-expansion of this lung. Note the massive atelectasis and mediastinal shift to the left).

Streptomycin therapy was started on April 27, 1947 consisting of one gram daily for one week then 0.5 grams daily, given in two divided doses. The treatment was continued for six months. Bronchoscopy on June 13, 1947 (seven weeks after institution of streptomycin therapy) disclosed complete clearing of the granulation tissue about the carina and the left main bronchus, but marked stenosis was observed just inside the left main stem bronchus. Left pneumonectomy was performed on June 18, 1947. (Fig. 3d, x-ray following left pneumonectomy and modified thoracoplasty. The scattered markings in the right lung are due to residual oil.)

The pneumonectomy specimen revealed a greatly thickened pleura measuring up to 0.3 cm. The lung was firm and practically non-crepitant. A bronchial stricture which had been present was not included in the specimen. No harm apparently resulted in two cases in which strictures were left behind. On section of the lung there were large areas of caseation encapsulated by fibrous walls. These areas were extensive throughout the entire lung and the intervening pulmonary parenchyma was collapsed. These caseous areas impinged upon the bronchi and some of the smaller ones were filled with caseous material. Microscopic section demonstrated the encapsulated caseous foci with intervening collapsed lung. In addition, there was active tuberculosis within the thickened pleura. Hilar lymph nodes were negative. The microscopic diagnosis was: multiple caseous foci, tuberculosis of moderate sized bronchi, caseous tuberculosis of the pleura, atelectasis and fibrosis. The sputum immediately became negative and the patient was discharged as an arrested case one year later.

Comment: From these findings, it is obvious that this patient had extensive tuberculosis of the bronchi and that pneumothorax was contraindicated. There was ulceration of some of the bronchi with secondary destruction of the bronchial cartilages. As this lung was the main source of the tuberculosis, it was constantly seeding the opposite lung. The lung itself was non-functioning and tending to heal. The pathologic changes, together with the stricture, made this an ideal case for pneumonectomy.

The second case of this subgroup had extensive involvement of the left main bronchus with low grade stenosis, but in addition, had tuberculous granulations and ulcerations about the left upper lobe bronchus with moderate stenosis. Although resection of the left upper lobe was contemplated, pneumothorax was first tried cautiously, but resulted in massive atelectasis of the upper lobe. Streptomycin was not available at this time. The lobectomy specimen (left upper lobe) showed encapsulated caseous foci, bronchiectasis with extensive endobronchial tuberculosis, and tuberculosis of the hilar lymph nodes. This case presented involvement of both the bronchi and parenchyma. It is obvious that pneumothorax was contraindicated in the presence of extensive endobronchial disease and bronchostenosis.

II. *Tuberculous Bronchiectasis*

Tuberculous bronchiectasis as a clinical indication for resection has been applied quite loosely in our series; cases presenting bronchographic evidence of bronchiectasis with a positive sputum were placed in this category. In tuberculosis, most cases of bronchiectasis follow previous parenchymal and/or bronchial disease. If tuberculosis of any extent involves the parenchyma of the lung, the bronchi leading to this involved area invariably show some degree of tuberculosis. With healing of the parenchymal process,

some degree of residual bronchiectasis remains. Usually it is asymptomatic and is in the upper lobe. If bronchograms are done, they may reveal structural alterations which will usually directly vary with the severity of the previous process. These bronchiectatic areas may show an occasional tubercle but it is questionable whether such changes should be dignified by the name tuberculous bronchiectasis. Bronchiectasis (mainly non specific, etiology tuberculosis) would seem to be a better diagnosis. In other instances (a much lower percentage) the degree of endobronchial tuberculosis may be prominent. In these cases the process can involve all sized bronchi. The pathology seen can be varied and bronchiectasis is an inevitable accompaniment. Our upper lobe bronchiectasis usually represented a burned out tuberculous process while the lower lobe bronchiectasis often showed active extensive endobronchial tuberculosis. Such changes could be designated as bronchiectasis with prominent endobronchial tuberculosis.

Rilance and Gerstl,[26] from their studies of 47 tuberculous patients with bronchiectasis, attempted to differentiate tuberculous and non-tuberculous bronchiectasis. But they differentiated the two conditions from a morphologic and etiologic basis. On the other hand, Mitchell and Thornton[27] stress the importance of positive sputum in establishing the diagnosis of tuberculous bronchiectasis.

From the surgeon's viewpoint, the diagnosis of tuberculous bronchiectasis should be made on a pathologic basis, difficult though this may be, as this condition is a surgical disease, amenable at this time only to resection. Through our studies, we feel that even though it is difficult to establish a diagnosis of tuberculous bronchiectasis, one can arrive at it in many cases with a reasonable degree of accuracy.

The endobronchial tuberculosis in an ectatic bronchus may range from an isolated tubercle (Fig. 4a), ulceration into a bronchus (Fig. 4b), to partial and complete destruction of the bronchial wall with obstruction and stenosis (Fig. 4c shows destruction of the bronchial wall). In diagnosing bronchiectasis with endobronchial tuberculosis the question arises as to where the dividing line may be between those cases with only rare submucosal tubercles and those with extensive involvement of the bronchi. From a practical point of view we now feel justified in making this diagnosis in the presence of persistently positive sputum, bronchographic evidence of bronchiectasis with absence of active parenchymal lesions, and with bronchoscopic evidence of disease. The location of the bronchiectasis may also furnish a clue. For example, of the 22 resection cases in the tuberculous bronchiectasis group (Group II), 11 had the bronchiectasis limited to the upper lobe.

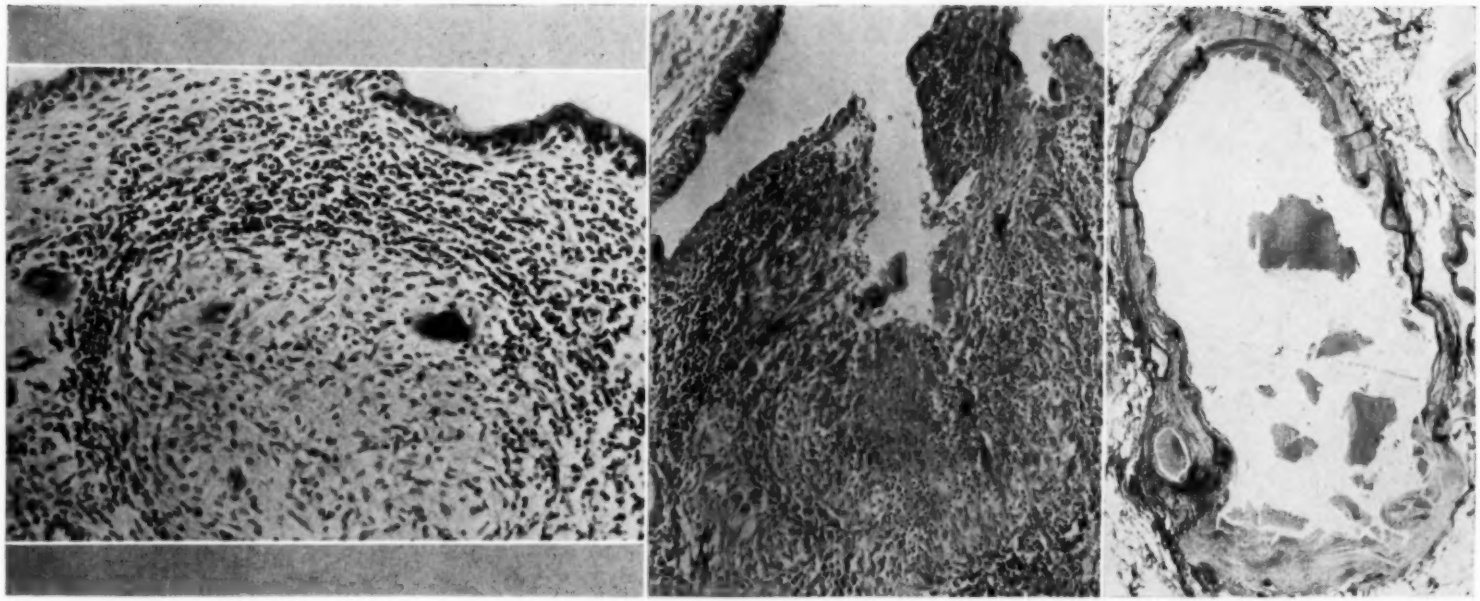


FIGURE 4a FIGURE 4b FIGURE 4c

Fig. 4a: Photomicrograph to demonstrate a submucosal tubercle. Note the overlying mucosa is intact.—*Fig. 4b:* Ulceration of a submucosal tubercle into a bronchus. Lining bronchial epithelium is to the left.—*Fig. 4c:* Photomicrograph which demonstrates an ectatic bronchus partially destroyed by tuberculous granulation tissue.

Of these, only one had moderately extensive endobronchial disease, the remainder having predominantly non-specific bronchiectasis. On the other hand, in the 11 remaining cases that had pathology in the middle and/or lower lobes, six had moderate to extensive endobronchial tuberculosis. The old axiom "upper lobe bronchiectasis, tuberculosis; lower lobe bronchiectasis, non-tuberculosis" is founded upon an etiological classification and certainly does not hold true in our cases.

Pathogenesis: The discussion of the pathogenesis of tuberculous bronchiectasis resolves into a discussion of bronchiectasis and of endobronchial tuberculosis. The presence of some degree of bronchial block plus bronchial infection is generally accepted as being a common cause of bronchiectasis. Foreign bodies, endobronchial disease, tumors, enlarged peribronchial lymph nodes, and mechanical kinking of a bronchus as seen frequently following thoracoplasty or extensive fibrotic disease may all partially occlude a bronchus with stagnation of secretions and infection distal to the point of partial block. The importance of atelectasis of the lung exerting an external pull on the bronchus as an etiological factor has been emphasized by Andrus[28] and Kent.[29] Hedblom[30] and others have also emphasized the effect of retracting parenchymal lesions with resultant fibrosis exerting a distorting effect on the bronchi, causing bronchiectasis. It is reasonable to assume that bronchiectasis can be caused by all these various factors and that different ones may cause bronchiectasis in various areas of the same tuberculous lung.

The pathogenesis of endobronchial tuberculosis has been the subject of considerable controversy in the literature. Theories have been advanced as to the mode of implantation of the tubercle bacillus in the bronchial submucosa. The lesions are in most cases secondary to a parenchymal focus and may take root in a bronchus by:

1) Direct implantation upon the mucosa;
2) Direct extension from neighboring structures, e.g. lymph nodes;
3) Spreading through the lymphatic system from the parenchymal focus;
4) Spreading through the blood stream.

Burgher, Littig and Culp[31] and later Huang,[32] from their study of 122 and 115 autopsy cases respectively, concluded that the predominant mode of infection was by direct implantation of tubercle bacilli upon the bronchial mucosa from the parenchymal focus. Silverman,[33] from a study of 110 autopsy cases, also arrived at the same conclusion.

Reichle and Frost,[34] from their study of 37 necropsies, concluded

that the predominant mode of infection was from the lung parenchyma through the lymphatics to the adjacent bronchi, and also that the peribronchial tuberculous lymph nodes may play a part in infection of the mucous glands of the bronchi by contiguous infection. Meissner[13] also believes that the lymphatics carry the bacteria from the parenchymal focus to the bronchial walls, this conclusion being drawn from his study of 60 surgical specimens. He found a high incidence of hilar lymph node involvement in these cases and stated, "Many of the lymphatics drain down the wall of the bronchus; the submucosa of the bronchus is also rich in lymphatics. Thus, the entire course of the bronchus . . . which leads from a parenchymal lesion is potentially subject to tuberculosis if tubercle bacilli will but lodge in its walls."

Miller,[35] from his studies of the valves in the lymphatic system of the lung, concluded that the flow of lymph in the bronchial and arterial lymphatics was towards the interior of the lung: that is, from the hilum toward the periphery; whereas the flow of the lymphatics accompanying the pulmonary veins and its branches is from the periphery toward the hilum. The flow of lymph at the communications of the superficial (pleural) and deep (pulmonary) set of lymphatics is always toward the pleura. Thus, it is hard to conceive of an extensive tuberculous process in the bronchi occurring consistently in a retrograde fashion from a parenchymal lesion down to the main bronchi.

Ornstein and Epstein[36] diagnosed tuberculous bronchitis clinically in eight cases with little or no manifest parenchymal disease. They believed that the infection was transmitted from the adjacent tuberculous lymph nodes by contiguity, and that reinfection of the parenchyma in some of these cases was caused by aspiration of the tubercle bacilli from the bronchial lesions. Silverman[33] reports one case in her series of tuberculous autopsies that had miliary dissemination without cavity formation, in which extensive tuberculosis of the walls of the small bronchi were found.

The tubercle bacillus is notorious in spreading through the path of least resistance, so undoubtedly all of the various modes of spread can and do occur as reported by the different investigators above. However, the most common method by which tuberculosis infects the bronchi appears to be by direct implantation.

In addition to the study of the surgical specimens, we have had the opportunity of following the clinical course of our patients before resection. As result of this correlated study, we feel that the mode of causation of the endobronchial pathology in our series was predominantly if not entirely by direct implantation. The incidence of endobronchial tuberculous infection in lower lobe bronchiectasis (55 per cent) of 11 cases was considerably higher

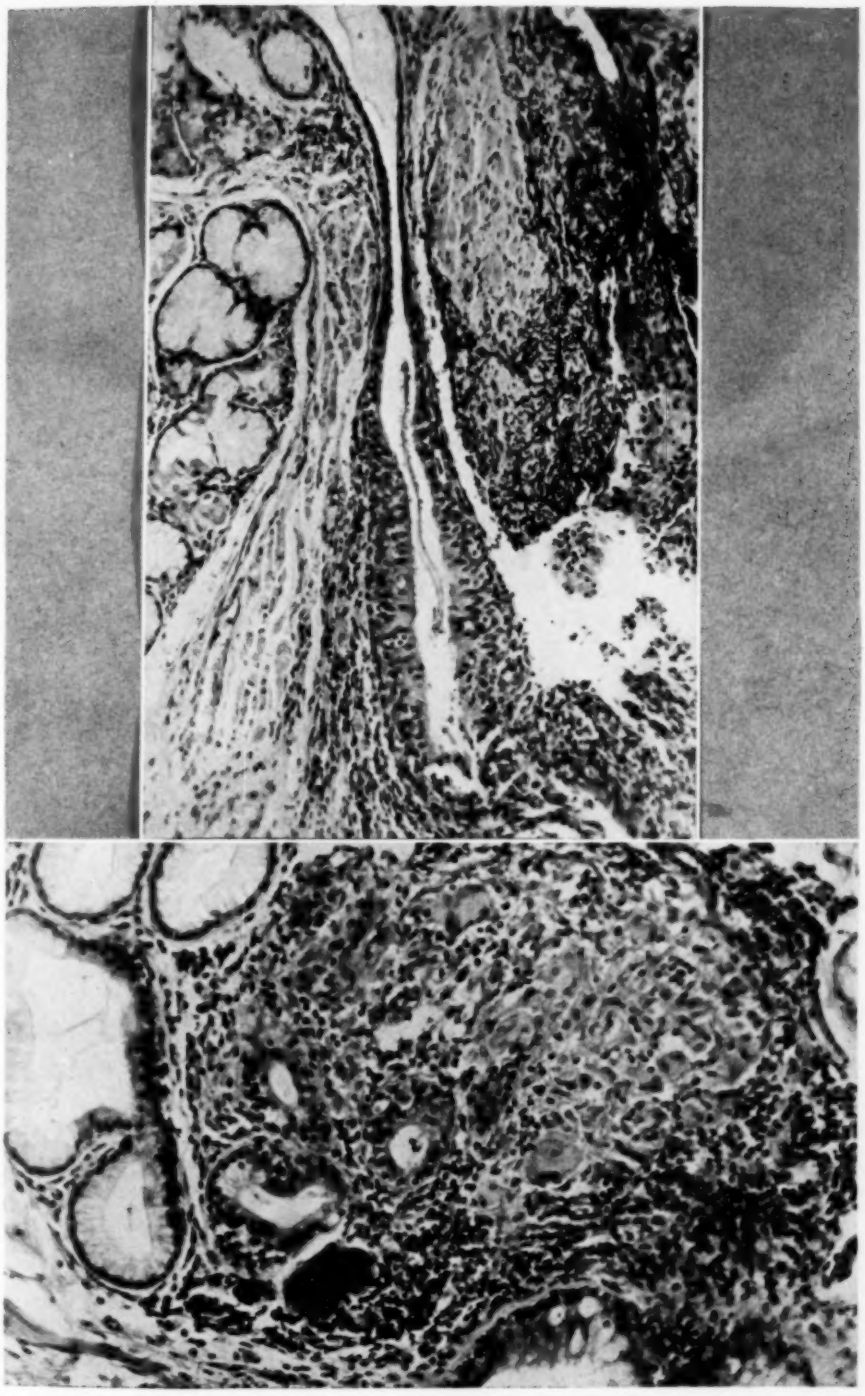


FIGURE 5: Photomicrograph which demonstrates (a, above) an open duct leading to (b, below) a tuberculous lesion associated with the mucous glands.

than in the upper lobe bronchiectasis (9 per cent) of 11 cases. Five of the cases in this group had previous thoracoplasties. In three with lower lobe bronchiectasis below thoracoplasties, there was rather extensive tuberculous involvement of the bronchi; whereas in the two cases of upper lobe involvement, the bronchiectasis was non-specific. Furthermore, the predominant pathology for which the thoracoplasty was performed was in the upper portion of the lung. In bronchiectasis, because of dependent drainage, cases with lower lobe pathology give rise to varying symptoms, whereas cases with upper lobe pathology are relatively symptom free. The dependency of the lower lobe bronchi in these cases might have favored more prolonged contact of the tubercle bacilli with the bronchial mucosa resulting in their implantation. In our studies, as were Meissner,[13] Reichle and Frost,[34] and Silverman,[33] we were impressed by the frequency of the presence of submucosal tubercles near mucous glands and ducts (Fig. 5a). Mucous ducts are quite abundant and it is reasonable to assume that the tubercle bacilli gain entrance to the submucosal tissues by this route (Fig. 5b).

Group II — Tuberculous Bronchiectasis

A. *Without Cavitation*

There were four cases in this sub-group, all with positive sputa and evidence of bronchiectasis. There was no roentgenologic evidence of atelectasis.

Case 3: (17364-1) B.S. White female, age 21; duration of disease at time of resection was eight months. Onset was gradual with productive cough, fever, and chest pains in August 1945. In December, she raised some blood streaked sputa, and entered the sanatorium January 1, 1946 with minimal tuberculosis of the left lower lobe and positive sputum. Bronchoscopy on January 11 revealed extensive ulcero-granulomatous lesions below the left upper lobe bronchus which were cauterized with 30 per cent silver nitrate. By March 15, the lesions had cleared (Figs. 6a and 6b). Left lower lobectomy was performed on April 24, 1946. This failed to convert her sputum, and an x-ray film three months postoperatively revealed ipsolateral and contralateral infiltrations. Bronchoscopy on August 2 revealed an ulcero-granulomatous lesion about the upper lobe orifice.

The larger bronchi of the left lower lobectomy specimen showed no evidence of ulceration. In the smaller bronchi were prominent granulomatous tuberculous masses growing within their lumina, and in some instances the small bronchi were completely occluded. The lung draining these partially or completely occluded bronchi demonstrated variable degrees of atelectasis and emphysema. The microscopic findings showed striking changes in the moderate-sized and smaller bronchi. These granulomatous masses often eccentrically replaced the walls of the bronchi distorting their normal configuration, ulcerating through the mucosal surfaces and partially or completely blocking the lumina (Figs. 6c and

6d). The microscopic diagnosis was: Bronchiectasis with endobronchial tuberculosis (extensive, productive, and occlusive) of the major and minor bronchi; tuberculosis of the hilar lymph nodes.

The patient became discouraged and left the hospital against medical advice on September 24, 1946, five months postoperatively. An out-patient roentgenogram taken in July 1948 revealed complete clearing of the lesions seen three months postoperatively.

Comment: This patient had extensive tuberculosis of the moderate and small sized bronchi. It was difficult to see how this process could have healed without causing permanent destruction of the lung parenchyma. This case shows with clarity how futile it would be to think that tuberculosis of the bronchi could be cured

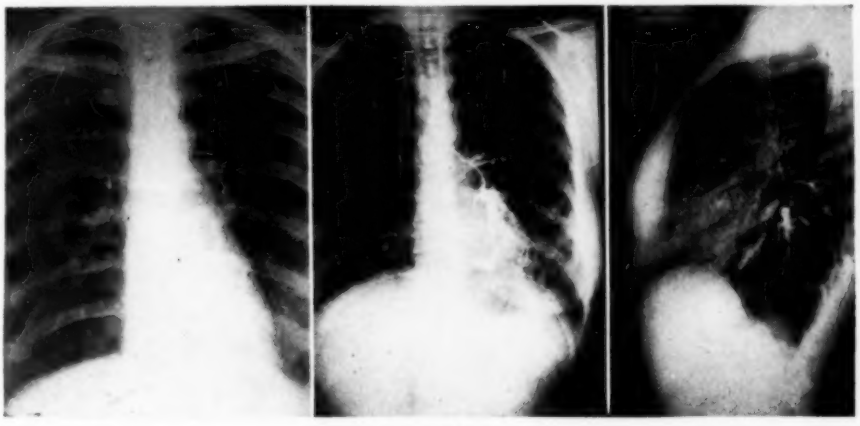


FIGURE 6a FIGURE 6b

Fig. 6a, 3-18-46: Note slight deviation of mediastinum to the left. No demonstrable parenchymal lesion.—*Fig. 6b, 5-29-46:* Bronchograms revealing bronchiectasis of left lower lobe.

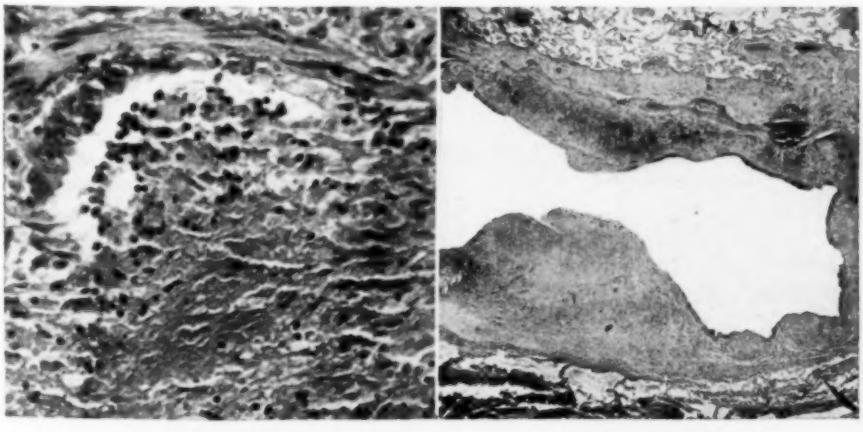


FIGURE 6c FIGURE 6d

Fig. 6c: Photomicrograph. Small bronchus is partially destroyed by tuberculous granulation tissue.—*Fig. 6d:* Photomicrograph. Eccentric partial occlusion of medium sized bronchus by tuberculous granulation tissue.

with silver nitrate cauterization of the major bronchi when such extensive tuberculosis of the minor bronchi exists. It demonstrates that collapse therapy in treating such productive endobronchial lesions could not be expected to cause any appreciable improvement, and might exacerbate rather than diminish symptoms. From the findings listed above, we feel that removal of this lobe was justified.

At the other extreme, the left upper lobe was removed from a 52 year old female with tuberculosis for a period of 30 years. This patient had positive sputum demonstrable only by culture, and bilateral fibro-calcific infiltration throughout the upper portions of both lungs, with evidence of bronchiectasis in the left upper lobe. This specimen revealed a non-functioning lobe with well encapsulated caseous nodules and considerable secondary non-tuberculous bronchiectasis. It is questionable whether this lobectomy was indicated, as the presence of predominantly nonspecific and symptomless bronchiectasis in an upper lobe in a patient with few signs and symptoms is not an indication for pulmonary resection.

1. *With Atelectasis and Fibrosis:*

There were three cases of tuberculous bronchiectasis without cavitation but with atelectasis and fibrosis. Two were lobectomies and one a pneumonectomy. This latter case and one of the lobectomies had negative sputa but the lungs presented the end result of extensive tuberculous processes with bronchiectasis and frequent small hemoptyses. The pneumonectomy case is presented below.

Case 4: (18005-46) A.W. White female, age 46; duration of disease over 13 years. She was a patient in the sanatorium from November 1934 to December 1937, at which time she was discharged as arrested. She developed a severe cold one month later and was re-admitted as a far-advanced case. She was again discharged as an arrested case in September 1939; the sputa all being negative during this period. In December 1944, she again developed positive sputum. She rested at home for a year, then returned to work. On regular check-up in October 1946, she was advised to re-enter for possible surgery, as there had been occasional small hemoptyses. She entered the Sanatorium in November 1946. She raised one to two ounces of purulent sputum in 24 hours, all specimens being negative for tubercle bacillus on smear, culture, and guinea pig inoculation. Vital capacity was 1600 cc. Electrocardiograms were within normal limits. (Fig. 7a is a bronchogram taken in June, 1938. Another bronchogram taken in December 1946 showed practically the same picture). Right pneumonectomy was performed on April 30, 1947.

The pneumonectomy specimen showed numerous fibrous adhesions over the surface of the lung. The hilar lymph nodes contained prominent calcification and caseation. Sections through the lung showed no evidence of cavitation but considerable bronchiectasis which was predominantly non-specific with occasional submucosal tubercles. There were

numerous calcified nodules throughout the lung and a few encapsulated caseous areas. Secondary emphysema was present (Fig. 7b). The microscopic diagnosis was: encapsulated caseous foci and fibrosis of the right lung; bronchiectasis, predominantly non-specific, with occasional submucosal tubercles; and caseous tuberculosis of the hilar lymph nodes.

The patient had a somewhat stormy postoperative course, but felt considerably better after the fluid was aspirated and the mediastinum shifted to the right as in the preoperative film. Unfortunately, postpneumonectomy thoracoplasty was performed on this case. When the mediastinum was again replaced to a normal position, a marked cardiorespiratory insufficiency developed and the patient expired 16 days later.

At autopsy, the contralateral lung disclosed no evidence of emphysema. There was considerable fibrosis of the pleura and lung, with edema, interstitial fibrosis, and encapsulated caseous foci. The heart was markedly enlarged (410 grams) and the walls of the hypertrophied right ventricle measured 1 cm. in thickness.

Comment: This patient had considerable impairment of pulmonary reserve before operation and was up in the age group in which pneumonectomy may be dangerous. There was no evidence of bronchial obstruction. In spite of the extensive bronchiectasis, the right lung had functioning pulmonary parenchyma. Death following operation was due to cardio-respiratory insufficiency. Although the contralateral lung was considerably enlarged in

FIGURE 7a

FIGURE 7b

Fig. 7a: Extensive bronchiectasis and atelectasis of right lung with shifting of the mediastinum to the right.—*Fig. 7b:* Gross specimen with prominent mainly non-specific bronchiectasis.

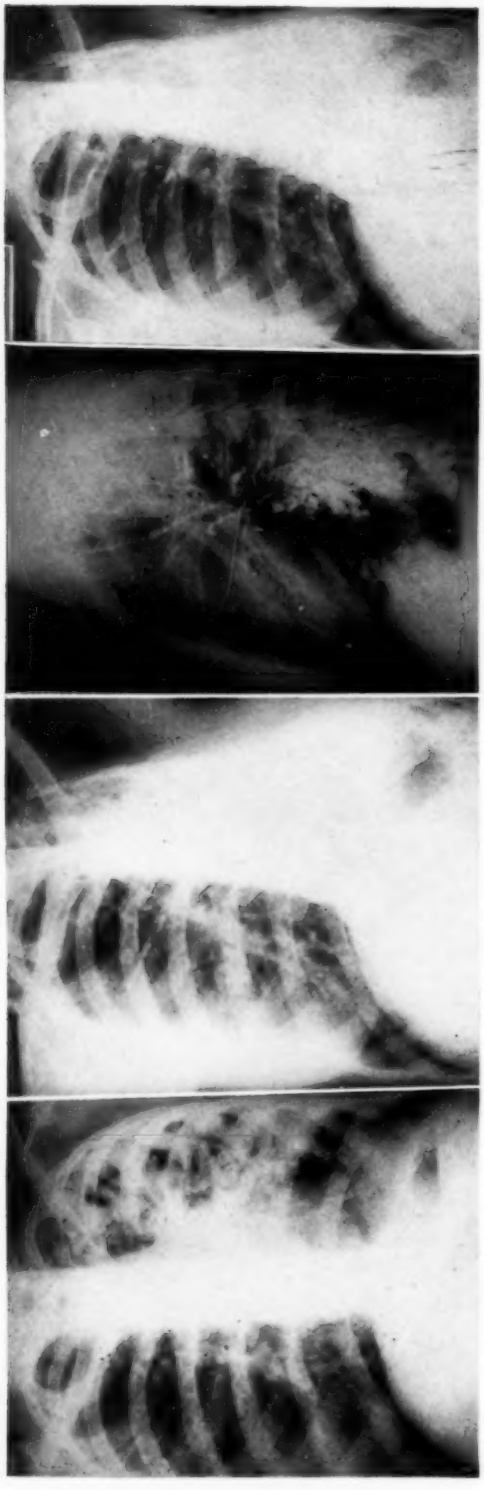


FIGURE 8a FIGURE 8b FIGURE 8c FIGURE 8d

Fig. 8a, 10-20-44: Note multilobular cavities with complete destruction of left lung.—*Fig. 8b, 5-23-46:* Roentgenogram after seven rib thoracoplasty.—*Fig. 8c, 11-15-46:* Extensive cylindrical bronchiectasis of left lower lobe.—*Fig. 8d, 9-2-48:* Post-lobectomy film (17 months).

volume due to the marked shifting of the mediastinum to the affected side, there was no evidence of emphysema. Ornstein[37] has stated that in cases of pulmonary resection, the contralateral lung does not become emphysematous but actually hypertrophies; and for this reason, he does not advocate post-pneumonectomy thoracoplasty to obliterate the empty pleural space. Post-pneumonectomy thoracoplasties are performed primarily to prevent rapid overdistention of the contralateral lung, thus preventing reactivation of healing or healed tuberculous lesions; and secondarily to minimize potential empyema by obliterating the pleural space. However, in certain cases (as case 4 above) where there is marked shifting of the mediastinum to the involved side prior to the resection, we now feel that post-resection thoracoplasty is not necessary and may at times be harmful.

Of the two lobectomy patients, one had negative sputum and was on exercise preparatory to discharge when she developed frequent hemoptyses which gradually grew in severity. Changes of non-specific bronchiectasis dominated the picture in the specimen and the tuberculous infection was minimal and well controlled. The second lobectomy case had positive sputum, and the bronchiectasis was borderline: that is, although only rare submucosal tubercles were seen, in one section the endobronchial tuberculosis was quite prominent with granulation tissue protruding into the lumen. The parenchyma showed caseous, lobular, tuberculous pneumonia which was tending to fibrose. We feel that in both of these cases the resection was justified, the indications being hemoptyses in one and bronchiectasis with endobronchial tuberculosis in the other.

2. *Previous Thoracoplasties*

a) *Without Empyema or Broncho-cutaneous Fistula:* The five patients in this group had bronchographic evidence of bronchiectasis with positive sputa following thoracoplasty. The lesions for which the thoracoplasties were performed were apparently controlled. The bronchiectasis in all cases was present on the side of the thoracoplasty, being in the upper lobe in two and in the lower lobe in three.

Case 5: (16489-36) E.J.S. White female, age 15; duration of disease over three years. Onset was acute with symptoms of a severe cold and hemoptysis in February 1944. She was admitted to the sanatorium on July 23, 1944 as a far-advanced case with severe symptoms and positive sputa. She was placed on strict bed rest, and left phrenemphraxis was performed in September 1944 (Fig. 8a, taken after left phrenemphraxis). Pneumoperitoneums were attempted but were unsuccessful due to discomfort. The left phrenemphraxis was repeated in September 1946. A seven rib thoracoplasty in two stages was performed the following February under

epidural anesthesia (Fig. 8b). Sputum was not converted, and bronchoscopy revealed considerable purulent sputum in the left lower lobe bronchus. Bronchograms disclosed an extensive cylindrical bronchiectasis of the left lower lobe (Fig. 8c). Left lower lobectomy was performed on April 2, 1947 (Fig. 8d).

The left lower lobe was practically non-crepitant. The hilar region was not remarkable. On section the bronchi were all moderately dilated. There were numerous caseous nodules throughout the lung measuring from 0.4 to 0.7 cm. Near the periphery, there were numerous small cavities which communicated with the bronchial tree. Microscopically, they were seen to be dilated bronchi. There were tubercles on the pleural surface and also tuberculous granulation tissue ulcerating into the walls of the small bronchi. Numerous single and conglomerate caseous foci were present (Fig. 8e). The microscopic diagnosis was: chronic tuberculosis with encapsulated caseous foci of the left lower lobe, bronchiectasis with endobronchial tuberculosis of the medium sized bronchi, and tuberculosis of the pleura.

Comment: It is doubtful whether collapse therapy would have improved this situation. The lobe was non-functioning and the process was tending to heal. There was extensive endobronchial tuberculosis. These factors seemed sufficient to justify lobectomy.

The two other cases of lower lobe bronchiectasis beneath thoracoplasties were similar to the case presented above clinically, radiologically, and pathologically. On the other hand, the remaining two cases who had upper lobe bronchiectasis proved pathologically to be predominantly non-specific. In both of them sputum was not converted following resection, and in one, an occult cavity was demonstrated by laminagraphs in the contralateral lung. In the second case, sputum was converted after further compression of the contralateral pneumothorax. These two cases indicate the importance of carefully checking for presence of occult cavities and infiltrations in the opposite lung.

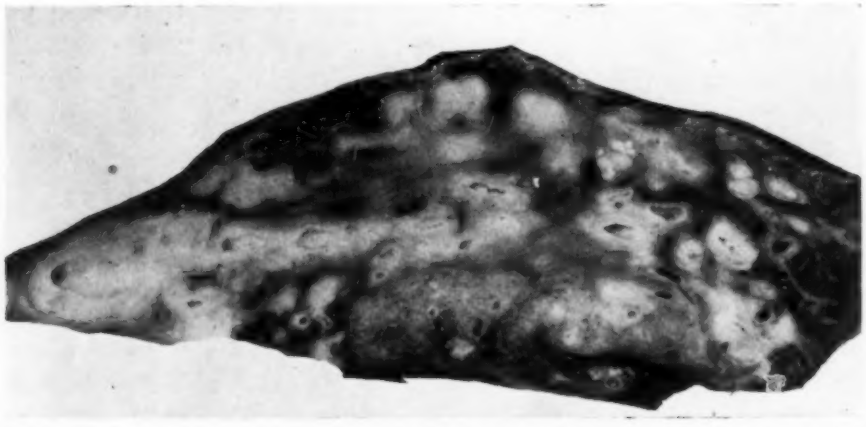


FIGURE 8e: Completely destroyed lobe with extensive bronchiectasis and encapsulated caseous foci.

b) *With Empyema and Broncho-cutaneous Fistula:* There were two cases in this group, both similar in that they had insufflated cavities when pneumothorax was instituted. Pneumothorax was abandoned and thoracoplasty performed, followed by tuberculous empyema and broncho-pleuro-cutaneous fistula. Both cases had bronchographic evidence of bronchiectasis with sputa and pleural drainage positive for tubercle bacilli, and showed predominantly non-specific bronchiectasis with only rare submucosal tubercles.

Case 6: (18131-77) C.S.R. White female, age 26; duration of disease over 5½ years. Onset was gradual in March 1942. She entered another sanatorium where right pneumothorax was instituted. She entered the Missouri State Sanatorium first in August 1942 for right pneumonolysis (Fig. 9a), which was followed by acute effusion. She was returned to her sanatorium in October 1942, where the pneumothorax was continued. However, because she developed empyema, bronchopleural fistula, and empyema necessitatis, she was returned to our sanatorium in January 1945 for thoracoplasty (Fig. 9b). Bronchoscopy on February 10, was not remarkable except for slight narrowing of the right main bronchus. A three stage nine rib thoracoplasty was performed between February 14 and April 18. A subscapular abscess was incised and packed in June. Sputa were not converted however, and she was returned to her sanatorium six months later.

She returned for further surgery on January 26, 1947 with a broncho-pleuro-cutaneous fistula, small empyema on the side of the thoracoplasty, and a four months pregnancy. Sputum was positive for tubercle bacilli. Bronchograms revealed moderate cylindrical bronchiectasis of the right lower and middle lobes, with some puddling in a small empyema pocket (Fig. 9c). A live baby was delivered normally in June 1947. Right pneumonectomy was performed on August 27, 1947. Streptomycin was administered for six weeks preoperatively and three months postoperatively, giving one gram daily for one week followed by 0.5 gram daily in two divided doses.

The right pneumonectomy specimen showed a nodular thickened pleura with a questionable bronchopleural fistula demonstrated in the upper lobe. Hilar lymph nodes showed areas of tuberculosis. On section the parenchyma was collapsed, containing numerous encapsulated caseous and calcified nodules. The bronchi were dilated with thickened walls. Microscopic examination demonstrated the fistulous tract lined by tuberculous granulation tissue. The surrounding lung parenchyma showed extensive fibrosis, encapsulated caseous foci, and collapse. There were rare tubercles in the bronchial mucosa. The microscopic diagnosis was: encapsulated caseous foci, bronchopleural fistula, fibrosis, and bronchiectasis, predominantly non-specific. Following resection, the cutaneous fistula closed and the sputa became negative (Fig. 9d).

Comment: This patient originally had a tension cavity. The pneumothorax followed by pneumonolysis was ineffective because tuberculous empyema complicated by a broncho-pleuro-cutaneous fistula developed. The thoracoplasty slightly improved the condition but the sputum remained positive. Pneumonectomy resulted in conversion of the sputa to negative and obliteration of the

FIGURE 9a

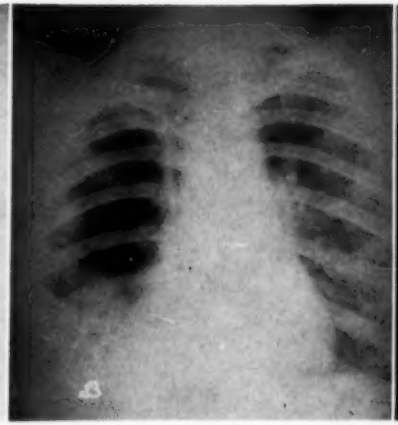


FIGURE 9b

FIGURE 9c

FIGURE 9d

Fig. 9a, 8-9-42: Right pneumothorax with persistent tension cavity.—*Fig. 9b, 1-30-45:* Complete collapse of the right lung with bronchial pleura fistula and empyema.—*Fig. 9c, 2-15-47:* Bronchogram with cylindrical bronchiectasis of the right lower and middle lobe with puddling in an empyema pocket.—*Fig. 9d, 2-27-48:* X-ray taken six months post-pneumonectomy.

fistulous tract. The removed lung was non-functioning. Pneumonectomy was the only surgical procedure which could have brought about a cure.

The second patient of this subgroup had a much larger empyema pocket with empyema of over 3½ years' duration at the time of resection. She had large hemoptyses, and resection was attempted as a life-saving procedure. She had evidence of amyloid degeneration and did poorly following resection, dying six months postoperatively of cardiac failure.

These two patients were classified under tuberculous bronchiectasis, as the sputa were positive and bronchiectasis was demonstrated by bronchograms. Had the bronchiectasis not been demonstrated, further thoracoplasty and perhaps Schede thoracoplasty might have been considered, particularly in case 6 presented above. In cases with bronchopleural and broncho-cutaneous fistula with empyema, however, we now feel that pulmonary resection is the procedure of choice and hereafter these complications will be considered as primary indications for resection. Sarot and Gilbert,[37] Davidson and Bailey[38] have developed a technic of operation whereby they perform extrapleural type of pneumonectomy and attempt a total extrapleural enucleation of the empyema pocket. Theoretically, this approach seems to be based on sound surgical principles. Of the three cases of tuberculous and mixed empyemas in our series, the empyema pocket was entered in all and partial decortication was performed with satisfactory results in two and a late death in the third.

3. *Pneumothorax Failure:*

There was one patient in the series in whom pneumothorax resulted in effusion, and the collapse was insufficient to control the disease or convert the sputum. Thoracoplasty was contemplated, but a routine bronchogram revealed bronchiectasis.

Case 7: (17775-8) E.W. White male, age 25; duration of disease over three years. Onset with left pleurisy in 1943. His local physician advised him to go to the Southwest, but the pains continued, so an x-ray film was finally taken in 1945 revealing an infiltration in the left upper lobe. The patient entered another sanatorium in April 1945, where left pneumothorax was instituted with resultant fluid. The pneumothorax was reexpanded, and the patient was referred to us in July 1946 for further treatment. He had hemoptysis of approximately one pint the preceding month. Bronchograms (Fig. 10a) in August 1946 revealed saccular dilatations of the anterior and apico-posterior segments of the left upper lobe. A diagnosis of tuberculous bronchiectasis was made and left pneumonectomy was performed on October 15, 1946, followed by a modified thoracoplasty six weeks later.

The left pneumonectomy specimen had a markedly thickened pleural surface. The hilar region was not remarkable except for questionable

tuberculosis of the hilar lymph nodes. On section, the bronchi to the upper lobe were dilated. No cavities of the upper lobe were identified. There were numerous well defined prominent caseous nodules throughout the lung and fibrosis of the intervening lung parenchyma was pronounced. The microscopic diagnosis was: encapsulated tuberculosis, and bronchiectasis with endobronchial tuberculosis. Postoperative course was smooth and the sputum was converted.

Comment: This patient had unsatisfactory collapse therapy by pneumothorax. Sputum was positive and the bronchograms showed bronchiectasis. Microscopic sections further demonstrated that there was considerable tuberculosis of all bronchi and that the lung was non-functioning. There was pronounced bronchiectasis with endobronchial tuberculosis in the upper lobe and extensive acinous-nodose infiltration of the lower lobe. Figure 10b shows a section through the lower lobe.

B. *With Cavitation*

1. *Without Atelectasis:*

There were four cases in this subgroup; three pneumonectomies and one lobectomy. All had demonstrable cavitation, positive sputa, and bronchiectasis of the lobe in which the cavity was located. A representative case is presented.

FIGURE 10a

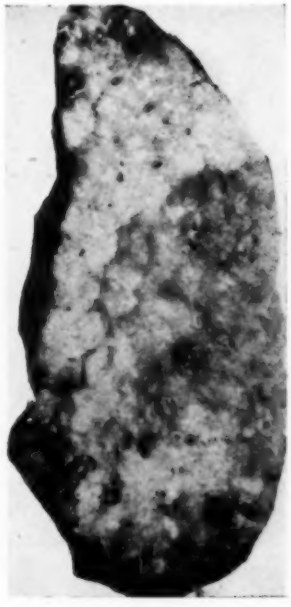


FIGURE 10b

Fig. 10a, 8-16-46: Bronchogram demonstrates saccular dilatation of the anterior and apical posterior segments of the left upper lobe.—*Fig. 10b:* Gross photograph of the right lower lobe which demonstrates confluent caseous lobular active tuberculous process.

Case 8: (18219-94) J.A. White female, age 30; duration of disease seven years. Onset with right pleurisy in January 1940, followed by a small hemoptysis the following month. She gradually became worse and tuberculosis was diagnosed in August. She first entered the sanatorium in October as a far advanced case with positive sputa. A right pneumothorax was instituted in November, and although a contra-selective collapse was obtained, it resulted in sputum conversion and so was maintained until fluid developed in July 1941. The lung was gradually re-expanded by repeated aspirations and right phrenemphraxis was performed in March 1943. She was discharged as an apparently arrested case in July.

Following discharge, she resumed her occupation as a beautician and was apparently in good health until August 1946, when she had an hemoptysis of three ounces. She began resting at home, but in January 1947, her sputum became positive, so she was re-admitted on March 16, 1947 as a moderately advanced case. At this time she had a moderate-sized cavity in the right apex, fibrosis and moderate retraction of the right upper lobe which was the site of disease 6½ years previously. Bronchograms revealed saccular and cylindrical bronchiectasis involving all segments of the upper lobe (Fig. 11). Right upper lobectomy was performed on October 13, 1947, followed by a modified thoracoplasty with removal of the upper four ribs; the fifth having been removed at the time of the resection.

The right upper lobectomy specimen showed fibrous pleural thickening at the apex. There was a cavity two centimeters in its greatest diameter at the extreme apex communicating with a bronchus. A confluent

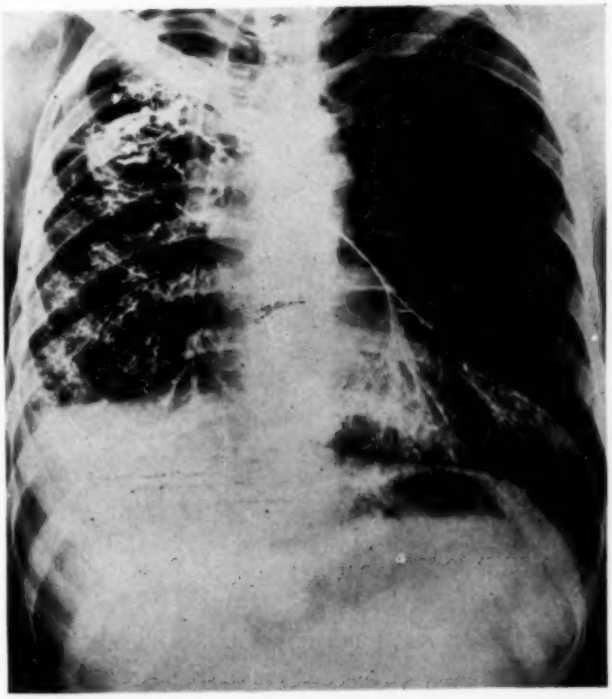


FIGURE 11, 4-5-47: Cylindrical and saccular bronchiectasis involving all segments of the right upper lobe.

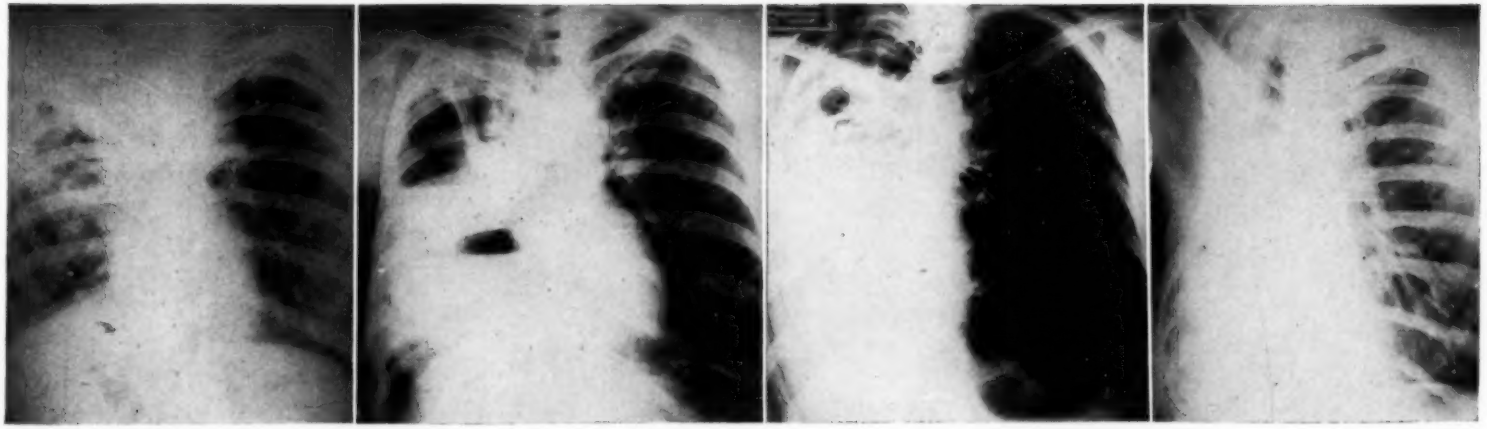


FIGURE 12a FIGURE 12b FIGURE 12c FIGURE 12d

Fig. 12a, 11-22-44: Extensive infiltration upper two-thirds, right lung, moderate infiltration, left mid lung field.—*Fig. 12b, 1-17-46:* Collapsed lung, right, with multiple fluid levels.—*Fig. 12c, 1-27-47:* Prominent shifting of the mediastinum to the right with pooling of oil posterior superior portion of the chest.—*Fig. 12d, 12-1-47:* Five months post-pneumonectomy.

grayish-white firm tuberculous process surrounded the cavity. The sections demonstrated considerable secondary bronchiectasis in the regions of the cavity with only rare submucosal tubercles. The surrounding parenchyma showed considerable fibrous tissue and encapsulated caseous foci. The microscopic diagnosis was: chronic tuberculosis with cavitation and bronchiectasis, predominantly non-specific. She has been consistently negative since surgery.

Comment: This patient had a residual open chronic cavity with secondary bronchiectasis, mainly non-specific. Although the lobe was non-functioning, it is debatable whether lobectomy was indicated. The source of the positive sputum was from the open cavity. This case might have been better treated by thoracoplasty, or at least the thoracoplasty might have been tried first.

Of the remaining four cases in this subgroup, three had similar findings and resections were probably not indicated. The fourth case was a 47 year old white female who had been ill for over 17 years, had extensive bronchiectasis throughout the entire lung, and a five centimeter cavity in the apex of the lower lobe. She had a great deal of bronchial thickening, bronchiectasis, and many of these dilated bronchi revealed numerous submucosal tubercles.

2. *With Atelectasis and Fibrosis:*

There were three cases comprising this subgroup, all having positive sputa, cavitation, atelectasis with mediastinal retraction to the affected side, and bronchographic evidence of advanced bronchiectasis. Pathologically, they were similar in that the bronchiectasis was predominantly non-specific.

Case 9: (16691-68) G.H. White female, age 39; duration of disease 5½ years. The onset was in March, 1942, with hemoptysis of one cupful, followed by cough and expectoration. However, tuberculosis was not diagnosed until a second hemoptysis in November 1944, at which time a roentgenogram was taken. She entered the sanatorium on November 21, 1944 as a far advanced case with a positive sputum and tuberculous laryngitis (Fig. 12a). Treatment consisted of a right phrenemphraxis and pneumoperitoneums. Five months after the institution of this therapy, she developed hydropneumothorax on the right (Fig. 12b). This was treated by aspiration and re-expansion. Laryngeal lesions were treated between December 1946 and April 1947 by cauterization with 30 per cent silver nitrate, but the patient remained quite hoarse. Bronchograms demonstrated a marked deviation of the trachea to the right and extensive pooling of oil in the postero-superior portion of the chest (Fig. 12c). As the contralateral lung appeared farily stable, right pneumonectomy was performed on July 23, 1947, followed in six weeks by a modified thoracoplasty (Fig. 12d). The hoarseness disappeared after correcting the tracheal deviation.

The specimen consisted of a markedly contracted right lung showing numerous adhesions and dense fibrous thickening of the pleural surface. There was moderate narrowing of the main bronchus within a few centimeters of its origin. The entire parenchyma was infiltrated with con-

fluent fibro-caseous areas. The markedly dilated bronchi contained only rare submucosal tubercles. A cavity measuring 3 x 2 x 1.4 centimeters was present in the apex; no direct bronchial communication could be established. Hilar lymph nodes contained fibrocaseous tubercles. The microscopic diagnosis was: chronic tuberculosis with cavitation, encapsulated caseous foci, bronchiectasis (predominantly non-specific), and tubercles of hilar lymph nodes. The patient has had a negative sputum since the resection and was discharged as an arrested case in September 1948.

Comment: The bronchiectasis in this case and in the two others of this subgroup was predominantly non-specific, but because it was advanced and because of the extensive involvement of the parenchyma, removal of these lungs was probably justified. The bronchograms of one of the other cases of this group are presented (Figs. 13a and 13b).

III. Destroyed Lung with Cavitation

One case was classified in this group as we were unable to introduce iodized oil because of a markedly distorted main bronchus. Clinically, it was felt that this patient, a white female, age 21, had extensive tuberculous bronchiectasis with cavitation, atelectasis, and fibrosis. The x-ray film of the chest was quite similar to those of the three patients in the previous group. This patient had been treated for an extensive endobronchial tuberculosis which improved under silver nitrate cauterization. Streptomycin was not administered preoperatively. The pathologic sections demonstrated rather extensive endobronchial tuberculosis and bronchiectasis of the large, medium, and small bronchi; a persistent cavity, encapsulated caseous foci, atelectasis, and fibrosis. In view of the pathologic findings, we feel that this resection was justified.

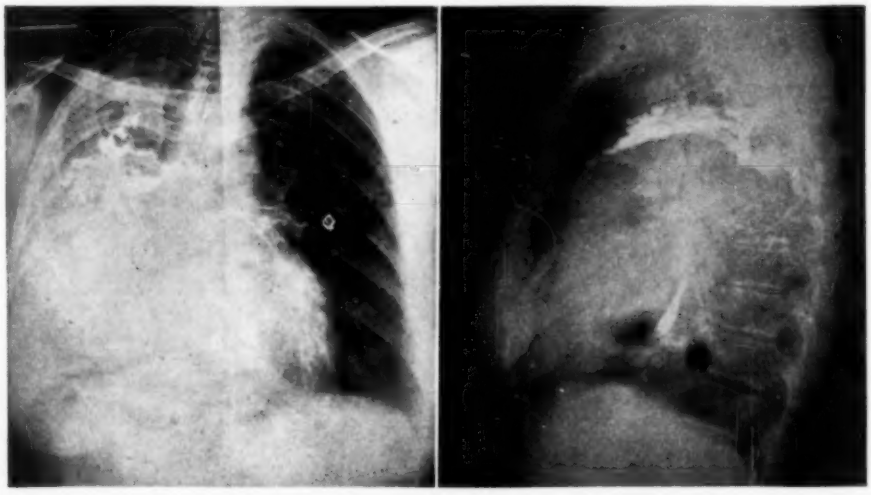


FIGURE 13a FIGURE 13b

Fig. 13a and 13b: Bronchograms to demonstrate extensive bronchiectasis of the right lung.

IV. Lower Lobe Cavity

There were two cases in this group, both with slight endobronchial involvement demonstrated bronchoscopically. In the first there was some submucosal infiltration and edema, and in the second superficial granulation tissue was present. Bronchograms on one demonstrated bronchiectasis and a primary resection was done. The second case was a phrenemphraxis and pneumoperitoneum failure, and is here presented.

Case 10: (16887-52) E.A. White female, age 22, duration of disease over two years. The onset was acute in the spring of 1944 with a cold, pleurisy and cough. Diagnosis was made in January 1945 and she was admitted to the sanatorium on March 13 as a far advanced case with positive sputa. There was no apparent improvement after six months of strict bed rest (Fig. 14a). Right phrenemphraxis was performed in September followed by pneumoperitoneums. Bronchoscopy in October revealed some superficial granulation tissue about the left main bronchus which was cauterized with 30 per cent silver nitrate. In August 1946, there was no evidence of endobronchial disease or stenosis; however, considerable purulent sputum was seen coming from the right lower and middle lobes. Right pneumonectomy was performed on August 21, 1946, followed by a modified thoracoplasty one month later (Fig. 14b).

The right pneumonectomy specimen showed hilar nodes with tuberculous involvement. On section, the upper lobe demonstrated scattered tubercles. The middle lobe was collapsed and revealed extensive bronchiectasis and endobronchial tuberculosis. In the lower lobe there was a huge cavity 7 x 5 centimeters (Fig. 14c). Microscopic sections of the bronchus leading from this cavity showed ulceration of its surface and metaplasia of its epithelium, together with tubercles in its submucosa. The microscopic diagnosis was: cavitation, bronchiectasis with endobronchial tuberculosis and encapsulated caseous foci of the right lower lobe; bronchiectasis and advanced endobronchial tuberculosis of the right and middle lobe bronchi, and acinous and acinous nodose foci in the right upper lobe. The sputa were converted to negative following resection. A temporary broncho-pleural fistula without empyema was present for a short time. The patient was discharged as an arrested case in December 1947.

Comment: The huge cavity of the lower lobe failed to close following the phrenemphraxis and pneumoperitoneums. The changes in the middle lobe were probably secondary to the pathology in the lower lobe. From the pathologic findings, it appears that pneumonectomy was indicated. The pathologic findings of the other case in this group were similar to the one presented above.

V. Thoracoplasty Failure

There were two patients in this group, both having residual cavitation and bronchiectasis. They were poor operative risks and both died of cardio-respiratory failure.

FIGURE 14a

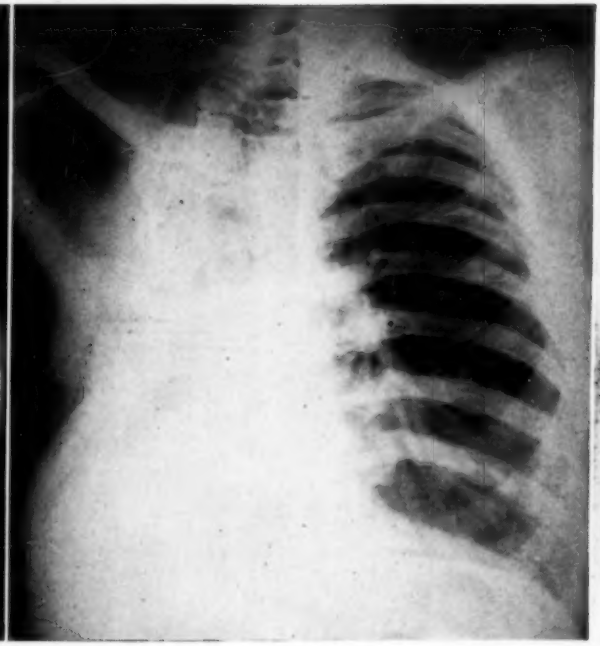


FIGURE 14b

FIGURE 14c

Fig. 14a, 8-21-45: Lateral view to demonstrate huge cavity posteriorly at the apex of the lower lobe.—*Fig. 14b, 5-12-47:* Nine months post-pneumonectomy and thoracoplasty.—*Fig. 14c:* Gross specimen to demonstrate huge cavity of the lower lobe.

Case 11: (18374-63) B.W. White female, age 65; duration of disease 16½ years. Onset was in January 1931 with an acute cold. First admission was in July 1931 as a far advanced case with positive sputa. In March 1932, right pneumothorax was attempted but was unsuccessful. Right phrenemphraxis was performed the following November and the patient was discharged to another sanatorium in October 1933 as unimproved.

The patient subsequently underwent three stages of right thoracoplasty at a third institution. She then worked until January 1946, when she developed productive cough, dyspnea and positive sputum. She was re-admitted to our sanatorium in July 1946 with a diagnosis of far advanced tuberculosis and hypertension for either a revision of the thoracoplasty or resection. This was not done as she developed congestive heart failure and symptoms of toxic nephritis. She was orthopneic with dependent edema and was returned to her sanatorium but insisted on resection because of severe, exhaustive cough and expectoration (Fig. 15). She was re-admitted here on June 11, 1947 with a moderately enlarged and tender liver, and engorged neck veins. Electrocardiograms showed left axis deviation with possible coronary insufficiency. Right pneumonectomy under the thoracoplasty was performed on July 2, 1947 as a last measure. The patient expired a few hours post-operatively of cardiorespiratory failure.

The specimen consisted of the entire right lung in which a large cavity in the upper lobe measuring 7 centimeters in its greatest diameter was demonstrated. The lung surrounding this cavity showed extensive fibrosis. The middle lobe was fibrotic and the bronchi to this lobe showed peribronchial fibrosis. The lumen of the bronchus to the lower lobe was narrow, and throughout this lobe were encapsulated caseous and fibrotic nodules. The sections demonstrated rather prominent bronchiectasis with minimal submucosal tubercles. The microscopic diagnosis was chronic tuberculosis with cavitation, encapsulated caseous foci, fibrosis, and bronchiectasis with minimal endobronchial tuberculosis.

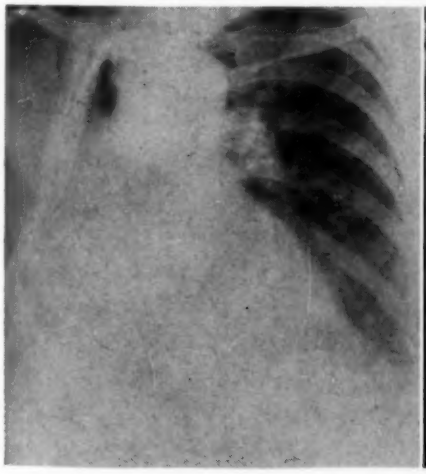


FIGURE 15

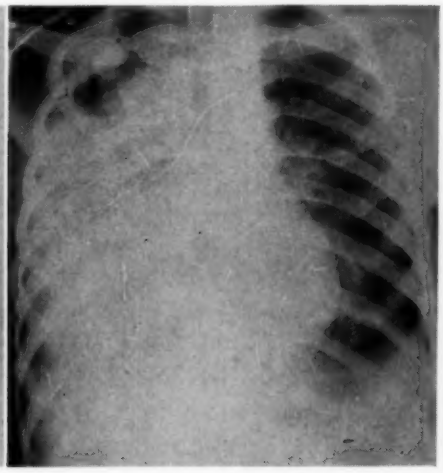


FIGURE 16

Fig. 15: Residual cavity under right thoracoplasty.—*Fig. 16:* Extensive caseous pneumonic process entire right lung.

Comment: Failure of collapse therapy is a generally accepted indication for resection. In cases of residual cavities following thoracoplasty, several procedures may be considered; namely, (1) revisional operation, (2) extrapleural packing, (3) some form of cavernostomy such as the flap drainage advocated by Eloesser, Rogers and Shipman,[39] or (4) resection. When the thoracoplasty collapse is not adequate, either the first or second procedures may be sufficient to control the disease. The flap drainage operation was performed successfully in 18 of 24 cases by Eloesser and his co-workers in dealing with insufflated cavities. However, this operation is followed by a prolonged period of convalescence. Resection is the most formidable of these procedures, but it is the most gratifying when successful.

The patient presented above was in the upper age group and died of cardio-respiratory insufficiency following operation. It appears obvious that when a patient of this age has so much damage, it is not worthwhile to undertake the risk of pneumonectomy.

The other case in this group was a 42 year old white male who also had a residual cavity and bronchiectasis. He developed symptoms and signs of cardiac failure in the third postoperative month and bronchopleural fistula with empyema in the fifth postoperative month; death occurred two months later. The surgical specimen was similar to the one previously mentioned, however, the bronchiectasis and endobronchial tuberculosis in the lower lobe was considerably more prominent than in the previous case.

Error in Diagnosis: There were two cases in this series in which the preoperative diagnosis was in error. The first was a 10 year old colored boy who was thought to have non-tuberculous bronchiectasis with pulmonary suppuration. All sputum studies were negative for tubercle bacilli. Only after the chest had been opened and the caseous hilar nodes found was the correct diagnosis realized. The entire lung was of liver-like consistency. As there was no radiologic evidence of disease in the contralateral side, the decision to resect was made at that time (Fig. 16). The microscopic diagnosis was: caseous, lobular tuberculous pneumonia of the right lung and caseous tuberculosis of the hilar lymph nodes. This patient developed empyema of the right pleural cavity which was apparently controlled by aspirations and instillation of 50,000 units of Drisdol twice weekly. Because of his physical underdevelopment, thoracoplasty was not performed. In the eighth postoperative month, he developed a bronchopleural fistula and a spread of the disease to the contralateral lung, and died the following month.

Young patients with little resistance to tuberculosis frequently present progressive caseous-pneumonic disease. Although this pa-

tient was apparently doing well following resection until the bronchopleural fistula developed, it is doubtful whether resections are indicated in cases showing this type of pathology.

The second case in this group was a 64 year old white female who was thought to have malignancy in the left upper lobe. She was the wife of a physician, and an x-ray film taken in 1942 (when she was 60 years old) was negative for any infiltration. She gave a history of frequent colds, and five weeks before admission, raised about one-half ounce of rusty sputum (Fig. 17a). Sputum and bronchoscopic examinations were negative. Laminagraphs revealed what was thought to be a circumscribed mass in the upper mediastinum and upper lobe (Fig. 17b). Pneumonectomy was performed, followed by thoracoplasty (Fig. 17c). The surgical specimen showed a conglomerate, encapsulated caseous foci (tuberculoma-like mass) (Fig. 17d). Following the resection, she had a moderate degree of

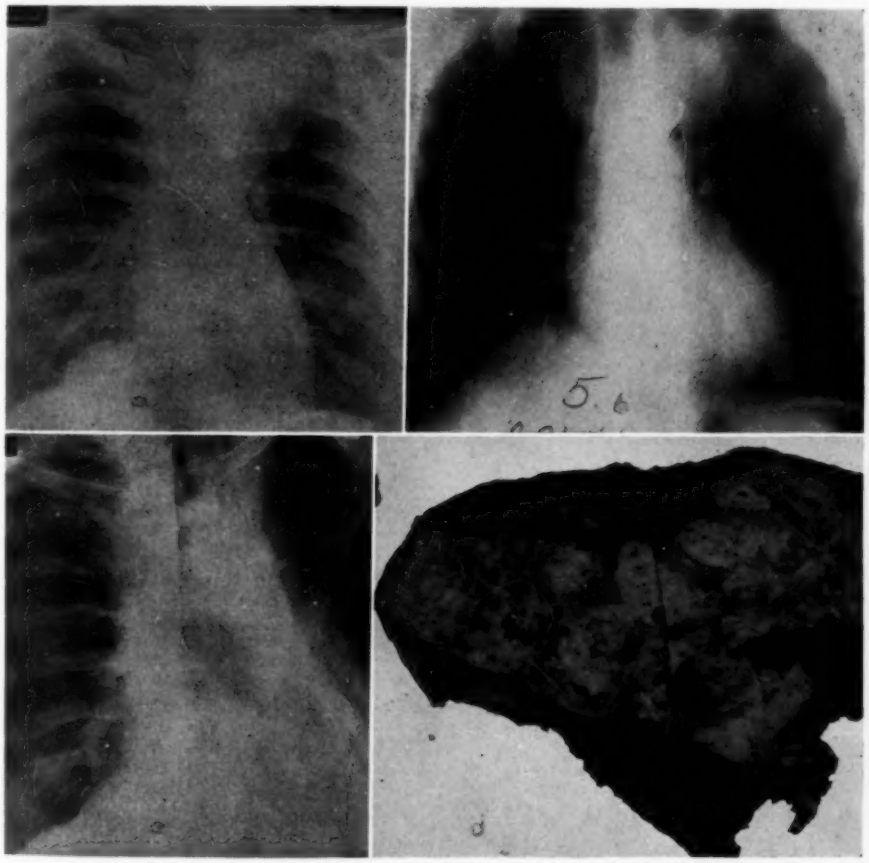


Figure 17a (above, left), 7-1-46: Poorly delineated shadow left upper lobe.—*Figure 17b (above, right), 8-24-46:* Laminagraph shows a fairly well delineated mass at left apex.—*Figure 17c (below, left), 3-10-47:* Post-pneumonectomy film.—*Figure 17d (below, right):* Gross specimen to show conglomerate productive tubercles simulating neoplasm roentgenologically.

respiratory embarrassment, and died one year later of bronchopneumonia without evidence of reactivation of the tuberculous process (proved by autopsy). She was in the upper age group where pneumonectomy is hazardous.

SUMMARY AND CONCLUSION

Thirty-four surgical specimens of tuberculous lobes and lungs were studied in order to correlate the clinical indications for resection with the pathology. Although the indications for resection are not clear cut, certain statements can now be made that may aid the surgeon in the selection of suitable cases.

The patient with tuberculosis has often been a chronic invalid with irreparable damage to his cardio-respiratory system. The advantages to be gained from the surgical procedure should be carefully weighed against the operative risk. With advancing age there is increasing morbidity and mortality, particularly from cardio-respiratory embarrassment. In addition to electrocardiograms and other clinical tests for evaluating cardiac reserve, estimations of ventilatory function and oxygen and carbon dioxide diffusion in the alveoli would be ideal particularly in those cases presenting contralateral pleural fixation, collapse, fibrosis or emphysema.

With the increasing availability of *streptomycin*, it should be administered preoperatively as well as postoperatively to all patients undergoing tuberculous pulmonary surgery. Its use apparently decreases the incidence of spreads by reducing the total volume of sputum and the number of bacteria. In certain types of cases, particularly those with *tension cavities*, the use of streptomycin may release the check-valve mechanism by healing the endobronchial tuberculosis, thus making the cavities amenable to the various collapse measures. In this way, streptomycin may decrease some of the indications for resection. At the same time, the drug often converts poor risk cases into cases suitable for surgery. Two patients in this series with severe endobronchial tuberculosis of the stem bronchus were resected without complications after streptomycin therapy. Most of our cases in whom resection was justified presented varying degrees of endobronchial tuberculosis.

The incidence of early postoperative spreads was 6.2 per cent (two cases out of 32). Of the 30 patients who were operated under epidural anesthesia, there was only one spread (3.3 per cent). We feel that the use of this anesthesia was also an important factor in reducing the incidence of spreads, as the patients were conscious and co-operative, being able to cough and expectorate throughout the operative procedure.

The clinical indications for resection in this series were:

1. Bronchostenosis.
2. Tuberculous bronchiectasis.
3. Destroyed lung with cavitation.
4. Lower lobe cavities.
5. Thoracoplasty failures.

Bronchostenosis, the end result of endobronchial tuberculosis, is a justifiable indication for resection. Bronchiectasis is almost always present distal to the stricture, usually with varying degrees of endobronchial tuberculosis. The healing of parenchymal tuberculous lesions usually results in bronchiectasis, varying in proportion to the extent of the parenchymal lesion. The resultant *upper lobe bronchiectasis* is usually non-specific and its mere presence without symptoms should not be an indication for surgery. When this pathology is present with positive sputum, careful search should be made for occult cavities or active infiltration. With upper lobe bronchiectasis plus cavitation, thoracoplasty probably should be tried first. *Bronchiectasis in the lower lung fields* is more apt to be complicated by endobronchial tuberculosis. In the absence of an active parenchymal focus but with positive sputum and evidence of bronchiectasis (condition frequently seen following adequate thoracoplasties) one may be justified in making a diagnosis of bronchiectasis with endobronchial tuberculosis. In cases presenting cavitation, massive atelectasis, fibrosis, and bronchiectasis with positive sputum (the so-called "destroyed lung") resection is the method of choice. Resection is also the procedure of choice in *chronic bronchopleural fistula with empyema.* The bronchus leading to the fistula is usually ectatic with endobronchial tuberculosis. In one of our cases, thoracoplasty alone was not successful in closing the fistula. In two, the resection was performed for hemoptyses. As the source of bleeding was from ectatic bronchi, they were classified in the "tuberculous bronchiectasis" group.

Lower lobe cavities are frequently complicated by endobronchial tuberculosis. With the introduction of streptomycin they may respond satisfactorily to collapse therapy. The two cases in this series did not receive streptomycin but the presenting pathology justified their removal. In *residual cavities following thoracoplasties,* there are several operative procedures that may be utilized, depending somewhat on the general condition and age of the patient. Resection is the most formidable of these procedures, but gives the most gratifying results. It is doubtful whether surgical resection even as a heroic measure is indicated in *caseous-pneumonic disease.* Although there were no *tuberculomas* in this series, these lesions should be resected as they often contain caseous

material and are always a potential source of spread. Radiographically, they oftentimes cannot be distinguished from neoplasms.

Future reports should state specifically the type of pathology found, particularly in those cases presenting bronchiectasis with or without endobronchial tuberculosis. Further studies may produce a uniform basis of classifying the indications and contraindications for resection in pulmonary tuberculosis, which may be further clarified by long and careful follow-up periods.

(All of the resections presented in this series were performed by Dr. W. W. Buckingham, Visiting Thoracic Surgeon. We are indebted to Dr. Charles A. Brasher, Superintendent of the Missouri State Sanatorium for his co-operation in the preparation of this paper).

RESUMEN Y CONCLUSIONES

Con el fin de correlacionar las indicaciones clínicas para resección con la anatomía patológica, se estudiaron treinta y cuatro especímenes de lóbulos o pulmones. Aunque las indicaciones no fueron muy precisas, ahora se pueden hacer algunos asertos que pueden ayudar a los cirujanos para la selección de los casos adecuados.

El enfermo tuberculoso ha sido frecuentemente un inválido crónico con daño irreparable cardio-respiratorio. Las ventajas que pueden obtenerse de un procedimiento quirúrigico deben ser cuidadosamente estimadas frente al riesgo operatorio. Al aumentar la edad hay un aumento considerable de la morbilidad y la mortalidad, principalmente debido a los trastornos cardio-respiratorios. Además del electrocardiograma para estimar la reserva cardiaca, serían ideales las estimaciones de la ventilación y la difusión del oxígeno y de anhidrido carbónico en los alveolos, especialmente en aquellos casos que tienen fijación contralateral, colapso, fibrosis o enfisema.

Con la creciente facilidad de obtener estreptomicina, se deberá emplear tanto antes como después de las operaciones en todos los enfermos sujetos a cirugía pulmonar. Aparentemente su uso disminuye la frecuencia de diseminaciones al reducir el volumen, los esputos y el número de las bacterias en ellos. En algunos tipos de afección, especialmente en los que tienen cavernas hipertensivas, el uso de la estreptomicina puede contrariar el mecanismo de válvula al curar la tuberculosis endobronquial y de ese modo se pueden hacer las cavernas susceptibles de responder al tratamiento por otras medidas de colapso. En cierto modo la estreptomicina puede reducir las indicaciones de la resección. Al mismo tiempo la droga a menudo convierte casos que son considerados como malos riesgos, en casos adecuados para la cirugía. Dos enfermos en esta serie, con grave tuberculosis endobronquial afectando el

bronquio principal, pudieron sufrir la resección sin complicaciones después de huberse tratado con estreptomicina.

La mayoría de los casos en los que la resección fué justificada presentaban grados diversos de tuberculosis endobronquial.

La frecuencia de las diseminaciones postoperatorias tempranas fué de 6.2 por ciento (dos casos entre 32). De los 30 enfermos que fueron operados bajo anestesia epidural, solo hubo una diseminación (3.3 por ciento).

Creemos que el uso de esta anestesia fué también importante factor para reducir la frecuencia de las diseminaciones, pues los enfermos estaban conscientes y cooperaban, capacitados para toser y expectorar durante toda la operación.

Las indicaciones clínicas para resección en estas series fueron:

1. Broncoestenosis.
2. Bronquiectasia tuberculosa.
3. Destrucción pulmonar con excavación.
4. Cavidades de lóbulo inferior.

Broncoestenosis, el resultado final de la tuberculosis endobronquial, es una indicación justificada de resección. Siempre hay bronquiectasis distal a la estenosis generalmente con grados variados de tuberculosis endobronquial. La curación de las lesiones parenquimatosas generalmente trae consecuentemente la bronquiectasis que varía en proporción a la extensión de la lesión parenquimatosa. La consecuente bronquiectasia de lóbulo superior generalmente no es específica y su sola presencia sin síntomas generalmente no es una indicación para resección.

Cuando este estado patológico se presenta, debe buscarse con cuidado si hay esputo positivo, para encontrar el foco activo o una excavación.

En la bronquiectasis asociada a excavación en lóbulo superior la toracoplastía debe ser intentada primeramente. La bronquiectasia de los campos pulmonares inferiores es más posible que se complique con tuberculosis endobronquial. En ausencia de foco activo parenquimatoso pero con esputo positivo y evidencia de bronquiectasia (cosa frecuentemente vista después de toracoplastías adecuadas) uno puede estar justificado para hacer el diagnóstico de bronquiectasia con tuberculosis endobronquial. En los casos que presentan excavación, atelectasia masiva, fibrosis y bronquiectasis con esputo positivo, (el llamado "Pulmón destruído"), la resección es el procedimiento de elección.

La resecci$n es también el método de elección en la fístula broncopleural con empiema. El bronquio que conduce a la fístula es habitualmente ectásico con tuberculosis endobronquial. En uno de nuestros casos la toracoplastía sola no logró clausurar la fístula. En dos, la resección se realizó por hemoptisis. Como la fuente de

la hemorragia fueron los bronquios ectásicos, se clasificaron como "bronquiectasia tuberculosa."

Las cavidades de lóbulo inferior frecuentemente están complicadas o con tuberculosis endobronquial. Con la introducción de la estreptomicina pueden responder satisfactoriamente al colapso. Los dos casos en estas series no usaron estreptomicina, pero la patología encontrada justificaba la extirpación. En las cavidades residuales después de toracoplastía, varios procedimientos pueden usarse dependiendo de las condiciones generales del sujeto y de su edad. La resección es el procedimiento más formidable pero dá los más satisfactorios resultados.

Es dudoso que la resección esté indicada aún como medida heroica en la afección caseoneumónica.

Aunque en nuestra serie no hay tuberculomas, estas lesiones deben sujetarse a resección puesto que a menudo contienen material caseoso que siempre es una fuente potencial de diseminación. Radiológicamente no pueden frecuentemente distinguirse de las neoplasias.

Informaciones en el futuro podrán especificar el tipo de patología encontrado particularmente en aquellos casos que presentaron bronquiectasis con o sin tuberculosis endobronquial. Estudios ulteriores podrán proporcionar una base uniforme para la clasificación de las indicaciones y contraindicaciones para la resección en la tuberculosis pulmonar, lo que se aclarará mucho más por el estudio de los enfermos seguidos largo tiempo.

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Results of Oral BCG Vaccination on 348 Families*

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At the time the planning of the present campaign against tuberculosis was initiated, the Director of the S.N.T. did his best to include among the various investigations destined to collect the most accurate possible data, a series on the results of the B.C.G. vaccination in our midst.

With this in view, Professor Paula Souza communicated with Professor Arlindo de Assis, Director of the Vaccination Services of the Ataulpho de Paiva Foundation, who immediately placed all the data contained in his files at the disposal of the controlling organization of the antituberculosis campaign. In a joint meeting, Drs. Assis, Paula Souza and Lincoln de Freitas Filho invited me as a technician in biostatics. After discussing the best way in which to develop a work which would be as close as possible to natural conditions, we decided to make an investigation in families in which there were vaccinated and nonvaccinated children. This would be the surest manner to guarantee social-economic, hygienic, nutritional, contagious and even hereditary conditions as similar as possible among the vaccinated and nonvaccinated children. They then contemplated the preparation of a map with a series of items, as follows:

1) Identification, with the following queries: number of card, color, sex, date of birth, and age at the end of observation.

2) Preliminary examinations: x-ray film, skin tests and home environment.

3) Immunization: Date of the first vaccination, date of first and second revaccination, and time elapsed between the first and second vaccination; also, time elapsed between the second and third vaccination.

4) Diagnosis of tuberculosis: Date of diagnosis, time elapsed between the beginning of observation and the date of diagnosis,

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results from sputum test or stomach washing, results of x-ray examinations, clinical type and the evolution of the process.

5) Death: date of death, time elapsed between the beginning of observation and the date of death, primary cause of death, secondary cause of death and results of necropsy.

6) Contagion: if intra- or extra-domiciliar, degree of contagion, duration, results of the sputum examination of the contagious source, results of the radiological examination, and finally the evolution of the disease.

Once the maps were prepared the Director of the S.N.T. entrusted me with the collection of data, using the files of the B.C.G. Service of the Ataulpho de Paiva Foundation, placed entirely at my disposal by its Director. After studying the contents of these files, I decided to include in the above mentioned maps all the families which had both vaccinated and nonvaccinated children, without bothering to separate those whose disparity in the data might make it impossible to compare the vaccinated with the nonvaccinated. This systematic inclusion facilitated a later examination, permitting a complete and immediate view of all the families included in these maps. Once this first phase was completed, I observed many uncertainties regarding the nature of the pathological findings. In order to verify the true etiology in the greatest possible number of cases, it was necessary to prepare a more detailed revision of all the suspect cases. I then divided the cases found, in two groups:

1) Known tuberculous morbidity: All children presenting a pathological pulmonary x-ray picture with a positive gastric lavage; all children who had not had a gastric lavage but whose radiological findings showed a ganglio-pulmonary process of typically tuberculous appearance, and finally those x-ray shadows which, by position or other characteristics in addition to a strong positive tuberculin reaction, left no doubt that we were dealing with a case of tuberculous origin.

2) Suspected morbidity: All children whose radiograph showed an atypical pulmonary or pleuropulmonary shadow, without lymph node involvement and of unknown or slow evolution, who had not had a gastric lavage or whose lavage was negative and with negative or moderately positive skin test.

All children who had fleeting pulmonary findings (less than a month) and whose reactions to the therapeutic agents used (sulfa drugs and penicillin) were of a nonspecific nature, were included among the normal children.

After I had included in the maps all the children belonging to families with vaccinated and nonvaccinated children, I could readily eliminate those whose control conditions did not allow a

comparative study. So that no preconceived ideas should interfere, I made a new map from which the data of morbidity and mortality were eliminated, allowing only a revision of conditions of control and contagion. Therefore, several families were eliminated with children whose age could not be correctly ascertained, or who had come to the Service for the last time at an age of less than 6 months, or even when the difference in age between the vaccinated and nonvaccinated was more than 10 years.

In this manner, the number of families was reduced to 348, with 479 vaccinated, and 461 nonvaccinated children, making a total of 940 children.

Studying Tables 1, 2 and 3, we discovered a great difference in the conditions of observation of the vaccinated and the control group especially with respect to the age at the beginning of observation. This is easily explained by the fact that vaccination in our community is mostly directed toward newborn infants, who are placed under medical control at 3 months of age, while the

TABLE 1
Age at the Beginning of Observation

	Vaccinated		Non-vaccinated		
	No.	Per cent	No.	Per cent	TOTAL
Under 6 months	227	47.4	8	1.7	235
From 6 to 12 months	77	16.1	18	3.9	95
From 1 to 2 years	38	7.9	24	5.2	62
From 2 to 5 years	61	12.7	112	24.3	173
From 5 to 10 years	63	13.1	198	42.9	261
Over 10 years	13	2.7	101	21.9	114
TOTAL	479	99.9	461	99.9	940

TABLE 2
Duration of Observation

	Vaccinated		Non-vaccinated		
	No.	Per cent	No.	Per cent	TOTAL
Less than 3 months	55	11.5	207	44.9	262
From 3 to 6 months	23	4.9	30	6.5	53
From 6 to 12 months	60	12.5	43	9.3	103
From 1 to 2 years	112	23.3	83	18.0	195
From 2 to 5 years	153	31.9	70	15.2	223
From 5 to 10 years	76	15.8	28	6.0	104
TOTAL	479	99.9	461	99.9	940

control group includes mainly the older brothers and sisters. The latter, who have not been vaccinated at birth, seek out the Service for the tuberculin tests and in this way the possible need for vaccination is discovered.

Passing on to the study of these control data, we will examine Table 1, with reference to the age of the children at the beginning of the observation. The difference in the numbers of the vaccinated and nonvaccinated is especially significant in the age group of 0 to 6 months, which is 47.4 per cent of the vaccinated group and 1.7 per cent of the control group. Even by grouping together all the nonvaccinated children of 0 to 2 years of age the percentage hardly reaches 10 per cent of the total, while the vaccinated group who began their observation in this period, is over 70 per cent. As we know that both tuberculous morbidity and mortality in infancy, is most acute in the first two years of life, it is easy to understand that this difference in age at the beginning of observation, is a considerable disadvantage for the vaccinated group. It is a fact, therefore, that some of the nonvaccinated children of the 348 families included in this investigation, had during this period a tuberculous process of mild evolution, retrogressing completely before they came under the observation of the Service, and also, others which progressed to death and which were not computed here, because they never came for observation.

Table 2 refers to the duration of the observation period. Here also, we will find a noticeable difference between both groups, which difference also favours the control group. While the majority of vaccinated children came several times for examination to the Vaccination Service, the nonvaccinated children were examined only once in about 45 per cent of the cases. Therefore, it is clear that the group having a periodic control will reveal a higher percentage of morbidity than the group whose period of control was much shorter. (See Table 2).

Still with regard to the method by which they were controlled, Table 3, shows us the age of the children at the end of observation. Here there is a greater similarity between the two groups, it being noted that there is a greater incidence of the nonvaccinated, among those that finished the period of observation beyond 10 years of age. This fact might give us an impression of disadvantage for the nonvaccinated group if it went on until 20 years of age, in which group is found the highest incidence of tuberculosis. For this reason, we systematically cut out all cases of morbidity which occurred after the 15th year of life of the children. (See Table 3).

After having dealt with the control conditions, the next consideration is with regard to sex, race, environment and conditions

of contagion. With regard to sex there is only a slight predominance of male children in the vaccinated group. (See Table 4). The study of race and environment, in both groups, brings us interesting information, showing the advantage of the investigation in families. Nobody ignores the importance of race and environment in the incidence of tuberculosis. It is therefore, essential, that when comparing groups of vaccinated and nonvaccinated, these factors be as similar as possible. The study of Tables 5 and 6 shows the distribution of race and environment in vaccinated and nonvaccinated children, which distribution can only be homogeneous through the study of families. (See Tables 5 and 6).

Studying the conditions of contagion to which the children were exposed, I tried from the beginning to discriminate as much as possible between the nature and various degrees of exposure. Unfortunately, I realized the difficulty in this procedure, because of the type of investigation in which the informing element is only the information card, the data of which usually are not sufficient. Therefore, I divided the contagion in three groups: Known, suspected and unknown. I considered the contagion as *known*, when it was possible to verify the existence of intra- or extradomiciliar contagion, with a tuberculous person discharging bacilli, or, if not knowing the sputum result, the radiographic examination, or evolution of the disease, demonstrated that the person

TABLE 3

Age at the End of Observation

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
From 6 to 12 months	39	8.1	11	2.4	50
From 1 to 2 years	88	18.4	16	3.5	104
From 2 to 5 years	171	35.7	96	20.8	267
From 5 to 10 years	140	29.2	192	41.6	332
Over 10 years	41	8.5	146	31.6	187
TOTAL	479	99.9	461	99.9	940

TABLE 4

Sex Distribution

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Male	256	53.4	204	44.2	460
Female	223	46.5	257	55.7	480
TOTAL	479	99.9	461	99.9	940

was discharging bacilli. *Suspected contagion* is a category for the child who lives or has lived in contact with a tuberculous person apparently cured, or also, when, in the case of collective living, there exists a tuberculous person discharging bacilli without apparent contact with the vaccinated child. Finally, I considered the contagion *unknown* when it was impossible to verify the existence of contagion, either intra- or extra-domiciliar. Without doubt, the ideal would be a classification according to the degree of exposure to contagion, as had been originally planned, but due to the impossibility of so doing, it is essential that there be a uniform criterion for the vaccinated and control groups. By ascertaining the incidence of contagion in both groups, we found that it was greater in the control group than in the vaccinated group. Adding up both types of contagion, *known* and *suspected*, this difference was slight (68.98 per cent against 63.04 per cent), but

TABLE 5
Race Distribution

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
White	290	60.5	278	60.3	568
Negro	94	19.6	103	22.3	197
Mulato	95	19.8	80	17.3	175
TOTAL	479	99.9	461	99.9	940

TABLE 6
Type of Habitation

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Individual	400	83.5	381	82.6	781
Collective	64	13.3	63	13.6	127
Unknown	15	3.1	17	3.7	32
TOTAL	479	99.9	461	99.9	940

TABLE 7
Incidence of Contagion

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Known	238	49.68	286	62.04	524
Suspected	64	13.36	32	6.94	96
Unknown	177	36.95	143	31.01	320
TOTAL	479	99.99	461	99.99	940

considering only those whose contagion could be verified, the difference increases noticeably (62.04 per cent against 49.68 per cent). This is, no doubt, a factor which might influence a greater incidence of tuberculous morbidity and mortality in the control group. (See Table 7). To counterbalance this apparent advantage of the vaccinated group, when we examine the age of the children at the beginning of contagion, we find that 58.6 per cent of the vaccinated group began contagion during their first year of life, while in the control group this percentage is only 22.2 per cent. (See Table 8). It is unnecessary to point out the importance of the child's age when submitted to contagion as it is a generally known fact. Another important factor, beyond the time of beginning of contagion, is without doubt, its duration. In this investigation, this was very similar in both the vaccinated and nonvaccinated groups, which fact can be verified by Table 9.

Analyzing these facts, we are obliged to admit that from the statistical point of view, this work contains some faults which are impossible to correct. It is true that some comparative data among the vaccinated and control groups are profoundly diver-

TABLE 8
Age at the Beginning of Contagion

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
First year	177	58.6	71	22.2	248
From 1 to 2 years	31	10.2	28	8.7	59
From 2 to 5 years	58	19.2	94	29.4	152
From 5 to 10 years	27	8.9	83	26.0	110
Over 10 years	9	2.9	43	13.5	52
TOTAL	302	99.8	319	99.8	621

TABLE 9
Duration of Contagion

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Less than 3 months	22	8.8	16	5.6	38
From 3 to 12 months	89	35.7	88	30.8	177
From 1 to 2 years	55	22.1	69	24.1	124
From 2 to 5 years	58	23.3	78	27.2	136
Over 5 years	25	10.0	35	12.2	60
TOTAL	249	99.9	286	99.8	535

gent, while others, such as race, environment, and time of exposure to contagion, are very close. What seems to us, however, of supreme importance, is the fact that, with the only exception of incidence of contagion all the divergent data favors the control group.

The criterion adopted by me for the calculation of incidence of specific morbidity in the two groups, has already been explained when I mentioned the classification of the cases found, in known and in suspected morbidity. At the same time, I removed all the findings which were proved nonspecific. Table 10 shows us the incidence of known and of suspected morbidity in the vaccinated and nonvaccinated groups, indicating that in the first case the morbidity of the control group was 4.2 times greater than that of the vaccinated group. (See Table 10). We can also verify the influence of contagion in the group of known morbidity. This verification once again shows the great importance of intense contagion in early infancy, and especially in the first two years of life. Therefore, our attention is drawn to the fact that both among the vaccinated and the nonvaccinated groups, the incidence of disease cases showed a percentage of more than 80 per cent in the group of known contagion while in the group of unknown contagion the incidence of morbidity was equal to zero among the vaccinated and of 12.9 per cent among the nonvaccinated. (See Table 11).

The data regarding mortality is unfortunately, very precarious. As in all ambulatory services, the knowledge of deaths is almost

TABLE 10

Tuberculous Morbidity

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Known cases	15	3.13	62	13.44	77
Suspected cases	5	1.04	15	3.25	20
TOTAL	20	4.17	77	16.69	97

TABLE 11

The Relation Between Known Cases and Tuberculous Contagion

	Vaccinated		Non-vaccinated		TOTAL
	No.	Per cent	No.	Per cent	
Known contagion	13	86.6	50	80.6	63
Suspected contagion	2	13.3	4	6.4	6
Unknown contagion	0	0	8	12.9	8
TOTAL	15	99.9	62	99.9	77

always obtained only by means of information given by relatives of the children. Necropsy was done only in one case which had been hospitalized in the tuberculosis ward of the Instituto Fernandes Figueira. As a consequence of these facts, probably more deaths occurred which will always be unknown, because the Vaccination Service was not notified, and also certain known cases in which death occurred sometime after the last control, leave some doubt as to the real cause of death. It is however, interesting to verify the results of the findings in the Mortality File of the Service, which reveals a specific mortality of 0.41 per cent (2 cases) in the vaccinated and of 1.73 per cent (8 cases) in the nonvaccinated, or in other words, in the same manner as regards to morbidity, the specific mortality rate of the nonvaccinated group was 4.2 times greater than that of the vaccinated group.

CONCLUSIONS

1) For the comparative study between vaccinated and nonvaccinated children, the investigation by families favors, without any doubt, a collection of more precise data than that carried out from heterogeneous sources.

2) Even so, certain items are profoundly divergent, and in both groups, with the sole exception of the greater incidence of known contagion in the nonvaccinated group, all the other factors were of a nature to cause a greater severity in the judgement of the results of the vaccinated cases as contrasted with the nonvaccinated cases.

3) The tuberculosis morbidity was of 3.13 per cent for the vaccinated group and 13.44 per cent for the control group, or, in other words, 4.2 times greater in the control group. The test X^2 with the Yates correction for the verification of the significance was equal to 31.6.

4) The specific mortality, like the morbidity, was also 4.2 times greater in the control group. In view of the small numbers found here, the X^2 test showed here the non-existence of significance.

CONCLUSOES

1) Para o estudo comparativo entre criancas vacinadas e nao vacinadas, a investigacao familiar favorece sem dúvida uma coleta de dados mais precisos do que a realizada em fontes heterogeneas.

2) Mesmo assim, certos itens divergem profundamente nos dois grupos, sendo que com a única excecao da maior incidencia de contágio conhecido no grupo dos nao vacinados, todos os outros itens foram de molde a influir no sentido de um maior rigor no julgamento dos resultados da calmetizacao.

3) A morbidade tuberculosa foi de 3.13% para o grupo vacinado e de 13.44% para o grupo controle, ou seja, 4.2 vezes maior no grupo controle. A prova chi² com a correcao de Yates para a verificacao de índice de significancia foi igual a 31.6.

4) A mortalidade especifica a exemplo da morbidade, foi tamgém de 4.2 vezes maior no grupo controle. Em virtude dos números pequenos aquí constatados, a prova de chi² mostrou aquí a inexistencia de significancia.

The Significance of Positive Cultures*

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There have been many reports in the literature about the value and necessity of examining cultures of fasting gastric contents and sputum in persons with sputum and gastric concentrates negative for tubercle bacilli. It is a common practice for gastric cultures to be done in patients without expectoration, or with negative or unsatisfactory sputum. About 30 per cent of sputum and gastric cultures are positive and without these laboratory methods, many patients actually positive would be considered negative. There is, however, a considerable difference of opinion about the interpretation of positive cultures. There have been few reports concerning the significance of positive cultures in relation to appraisal of the arrest of the disease, prognosis, need for hospitalization, or treatment.

Ordway, Medlar and Sasano[1] raised many interesting problems about the value of cultures. They believe that only a minor percentage of patients discharged from tuberculosis institutions would fail to intermittently shed tubercle bacilli. This is also true after pneumothorax or thoracoplasty. In other words, patients may be well clinically, and not active, but pathological cure is rare. But they state it would be an unjustifiable hardship upon the tuberculous individual to segregate him indefinitely, or keep him in a sanatorium until negative by all laboratory methods.

Chang[2] has reported the prognostic significance of occasionally positive sputum after adequate treatment of tuberculosis. He followed for two years or more 864 patients discharged as arrested or apparently arrested. During the last six months of sanatorium care, at least six cultures were done, and if one or two were positive, the patient was considered to have an occasionally positive sputum. The reactivations of patients with sputum negative for tubercle bacilli on culture and guinea pig inoculation were compared with patients with occasionally positive sputum, and those with sputum negative on direct examination only who had no cultures. The last two groups had a comparable recurrence rate of tuberculosis which was twice that of the first group. Chang concludes that patients discharged with occasionally positive spu-

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tum experience a reactivation of their tuberculosis more frequently than those with unequivocally negative sputum.

Abeles[3] also studied the significance of positive cultures in apparently adequately treated pulmonary tuberculosis. One hundred ninety-nine patients discharged as apparently arrested or arrested were observed for an average period of 44 months. One hundred four patients had only negative cultures and 95 had occasional positive cultures during a six month period prior to discharge. Thirty-six of the 199 patients were readmitted to a sanatorium or treated at home for a reactivation of their disease. Twenty-five of the readmitted patients had positive cultures and 11 had negative cultures during the six months before discharge. The cumulative rate of readmissions at the end of four years following discharge was 28.5 per cent for the patients discharged with positive cultures and 10.5 per cent for those discharged with negative cultures.

Material for Study

In order to determine the significance of positive cultures, patients were selected in whom all sputum and gastric concentrates were negative and only the cultures were positive. The patients were divided in 3 groups—those with a single, occasional, or majority of the cultures positive, respectively. These positive cultures were correlated with the roentgenologic changes, clinical course, laboratory findings, treatment in the sanatorium, and the status of the patient after discharge.

Observations:

Group I — Patients with a single positive culture: Group I consists of 29 patients (14 male, 15 female; with moderately advanced lesions in 14, minimal in 15, and the infiltration unilateral in 21 and bilateral in eight). These patients had but a single positive culture during their stay in the sanatorium. All other sputum and gastric concentrates and cultures were negative. No patient was included unless there was at least six months of institutional treatment after the positive culture. The average sanatorium length of stay was 8.4 months.

There were 29 positive cultures (26 gastrics, three sputum) and 191 negative cultures (174 gastric; 17 sputum), an average of one positive and 6.6 negative cultures per case. The concentrates totaled 539 (336 sputum; 203 gastric), an average of 18.5 per patient. The cases have been analyzed according to the type of infiltration and the roentgenologic changes at the time of the positive culture. This is shown in Table 1.

The terms used in describing the type of infiltration and roent-

genologic changes are defined as follows: Exudative-productive—mixed infiltration with a combination of soft, hazy, ill-defined shadows and hard, nodular and linear, well demarcated lesions with the principal roentgenologic character of a soft nature in these patients; predominantly productive (exudative-productive)—mixed infiltration with some exudative elements but the total extent of the lesion mostly productive in type; productive-fibrotic—typical, hard nodular and linear infiltration. Progression refers to an actual increase in the extent of lesion or cavitation. Resolution means resorption of exudative areas or increase in fibrosis.

The single positive culture was unassociated with any roentgenologic change in 22 patients (76 per cent of the total group); in 6 patients (20 per cent), those with a considerable or slight exudative character in the infiltration, resolution or increase of fibrosis took place, while in no patients did progression occur. The resolution was usually slight in degree and appeared at various intervals after admission. One positive culture was correlated with alteration in the degree of pneumothorax collapse. The positive culture was of questionable significance in the other pneumothorax cases. In many of the cases with no roentgenologic changes, the positive culture was present at the time of admission and was associated with the type of infiltration.

As regards the sanatorium course after the positive culture, there was no change in 16, resolution in 10 (seven exudative-productive and three predominantly productive [exudative-productive]), progression in two (one exudative-productive and one pneumothorax), and one patient had progression, then resolution (predominantly productive [exudative-productive]). The roentgenologic changes after the positive culture were thus limited principally to the exudative-productive cases and consisted usually

TABLE 1

Group I — Roentgenologic Changes at Time of Positive Culture

Type of Infiltration	No. of Cases	None	Resolution	Progression	Alteration in degree of Pneumothorax
1. Exudative-productive	11	8	3	0	0
2. Predominantly Productive (Exudative-productive)	8	5	3	0	0
3. Productive-Fibrotic	5	5	0	0	0
4. Pneumothorax	4	3	0	0	1
5. Pleural Effusion	1	1	0	0	0
TOTAL	29	22	6	0	1

of resolution. In the productive-fibrotic cases there were no alterations in the lesion at the time of the positive culture or thereafter, indicating the lack of significance of the positive culture in these patients. It was evident from the observations in this group that the tuberculous lesion could change much, though many sputum and gastric concentrates and cultures remained negative. A single positive culture may also be of diagnostic importance and represent the only bacteriological evidence of tuberculosis.

At the time of follow-up, i.e., the final observation after sanatorium discharge, the patients were considered to be either in satisfactory condition or not. A satisfactory status means negative sputum, good general condition, stable lesion and a full day's work tolerance (except in patients seen only a few months after discharge). Patients with at least two years' observation after leaving the institution would, if classified as satisfactory, be considered apparently cured. An unsatisfactory status means progression of the lesion and/or positive sputum or rehospitalization.

In Group I at time of follow-up, 20, or 69 per cent, were in satisfactory condition; six, or 20 per cent, unsatisfactory; two (7 per cent) had died, and one had an unknown status. The six unsatisfactory cases included four of the exudative-productive group, one with pneumothorax, and one with pleural effusion. The two deaths were pneumothorax cases. The poor results in the patients admitted with pneumothorax are probably related to the fact that three of these four patients had contralateral infiltration which changed later.

Concerning the period of follow-up, 12 patients were seen up to one year after discharge, 11 from one to two years, four from two to three years, and one at four and one half years (one case was not followed).

Group II — Patients with an occasional positive culture: This group includes 44 patients with an occasional positive culture, though in 28 of these 44 cases, consecutive positives also occurred. The total number of positives in every patient was less than half of all the cultures. In this group 26 were males, 18 females, with the lesions moderately advanced in 27 and minimal in 17. The disease was unilateral in 28 and bilateral in 16. There was at least six months' sanatorium observation after the first positive sulture, with the average stay 15.3 months. All of the sputum and gastric concentrates in these patients were negative, a total of 1475 (939 sputum; 536 gastric), an average of 33.5 per patient. There were 438 negative cultures (370 gastric; 68 sputum), an average of 9.9 per case, and 147 positive cultures (134 gastric; 13 sputum), an average of 3.3 per patient. As regards positive cultures, there were

19 patients with 2 consecutive ones, five with three, one with four, and three with two and three successive positives.

The roentgenologic changes associated with the positive cultures have been considered according to the type of lesion or treatment. These findings are outlined in Table 2.

In listing the findings in these patients with multiple positive cultures, the final outcome in the behavior of the infiltration was considered. Every individual positive culture was not associated with a change in the lesion but if with a series of positive cultures either resolution or progression occurred, the case was listed as such. The change may have taken place at any time during the sanatorium observation of the individual but must have been associated with the positive cultures. If no roentgenologic changes occurred with all of the positive cultures, the patient was classified under "None" in the table. If both resolution and progression were evident, that would be noted under a separate heading.

Of the 44 patients, the occasional positive cultures were associated with no roentgenologic changes in 16, or 36.3 per cent; resolution in 16, or 36.3 per cent; progression in three (6.8 per cent); resolution, then progression in four (9 per cent); pneumothorax in three (6.8 per cent), and alteration in degree of pneumothorax in two (4.5 per cent).

1) In each of the five patients with cavitation, positive cultures were associated with the admission lesion. Three had pneumothorax and their cultures remained positive while the pneumo-

TABLE 2

Group II — Roentgenologic Changes at Time of Positive Cultures

Type of Lesion	No. of Cases	None	Resolution	Progression	Resolution, Then Progression	Pneumothorax	Alteration in Degree of Pneumothorax
Cavitation	5	0	2	0	0	3	0
Exudative-Productive with suspicious highlights	5	0	3	2	0	0	0
Exudative-Productive	14	2	8	1	3	0	0
Principally Productive (Exud.-Prod.)	5	2	3	0	0	0	0
Productive-Fibrotic	7	7	0	0	0	0	0
Pneumothorax	4	1	0	0	1	0	2
Thoracoplasty	4	4	0	0	0	0	0
TOTAL	44	16	16	3	4	3	2

thorax was partial and not selective, but with closure of the cavities, aided by intrapleural pneumonolysis, the cultures became and remained consistently negative. In the other two cases the cultures were positive while resolution continued with bed rest and became negative with final cavity closure. The sensitivity of the cultures and correlation with the changing lesions—resolution and cavity closure—is well demonstrated. The cultures also indicate the effectiveness of the pneumothorax; for only after selective collapse and control of the lesion do they become negative.

2) In the five patients with exudative-productive lesions and questionable annular areas, the cultures were positive with the infiltration and then changes occurred in the lesions and cultures. In two patients cavitation became definite, and after selective pneumothorax, the cultures were converted. In the other three the cultures continued positive while resolution of the infiltration took place and after disappearance of the suspicious highlights became negative. The persistence of positive cultures in the presence of an unchanged roentgenogram with suggestive highlights is significant. These cases should be considered active for the cultures warn of actual cavitation which may occur, or they remain positive with cavitation present and continue so with resolution until healing is definite.

3) In the 14 cases with exudative-productive lesions, the significance and sensitiveness of the positive cultures was indicated by the fact that they were associated with roentgenologic changes in all but two. Most commonly resolution occurred (eight cases), in three resolution then progression, and in one, progression. It is interesting and important to know that resolution can cause or be associated with positive cultures. Resolution, of course, indicates instability of the tuberculosis. As fibrosis became apparent, the positive cultures were less often associated with visible roentgenological changes. The cultures follow no definite pattern all the time. There may be no roentgenologic changes with an occasional positive culture and sometimes they precede or warn of an impending spread of the lesion or are associated with progression. Patients with positive cultures would need close observation, for with final stability of the infiltration, the cultures do become negative. One of these patients had pneumothorax and in this case two positive cultures occurred six months after therapy started and were of questionable significance.

4) There were five patients with principally productive (exudative-productive) lesions. In two, the positive cultures were unassociated with changes, while in the other three, slight resolution occurred. The cultures became negative as fibrosis was established.

5) Seven patients had productive-fibrotic infiltration although

in two the lesion had a moth-eaten appearance. All of the positive cultures occurred with no visible changes in the roentgenograms, and some of the patients were ambulatory with the positive cultures. Apparently in productive lesions an occasional positive culture can occur without significance.

6) In the four pneumothorax cases, the positive cultures were associated with alterations in the degree of collapse in two, with no roentgenologic changes in the third, and with definite resolution, then progression of the infiltration within the pneumothorax lung in the fourth. The presence of an occasional positive culture at intervals up to 15 months after initiation of the pneumothorax with slight changes in the degree of collapse may be of questionable significance, or indicate that healing within pneumothorax takes time or that the collapse should be altered to control the disease.

7) In the four postthoracoplasty cases, the positive cultures were unassociated with visible x-ray changes and were found at various intervals—up to 13 months after operation in two patients, and during the second year in the other two though fewer positives occurred the second year postoperatively. The healing process is apparently slow after thoracoplasty and the cultures are the last bacteriological specimens to become negative. With this gradual arrest of the disease an occasional positive culture can be expected, particularly during the first year and less often the second year after operation without indication of "malignant" or active tuberculosis. The cultures can be used to evaluate the end result of the operation as this cannot be determined from the roentgenogram alone.

At time of final observation, 31 of the 44 patients in Group II were in satisfactory condition (70.4 per cent) eight unsatisfactory (18 per cent) and five were not followed. The unsatisfactory cases included two of the exudative-productive, cavitation, and productive-fibrotic cases respectively and one of the pneumothorax and principally productive (exudative-productive) patients. The progressions in the productive-fibrotic cases occurred in the two with moth-eaten appearance of the lesion. It seems that while positive cultures may not be significant in frankly productive tuberculosis, in moth-eaten lesions they should be regarded as indicative of active disease. As regards the period of follow-up, five patients were not seen, 10 were observed up to one year after discharge, 21 from one to two years, five from two to three years, and three from four to five years.

We have also observed patients with an occasional positive culture where, in addition, one or more positive sputum or gastric concentrates were present. The positive cultures had the same significance as described for the Group II cases. However, in the

cases with progression, the positive cultures would often precede definite cavitation and the positive sputum concentrates. In patients given pneumothorax, the sputum concentrates would become negative first, the gastric concentrates next, and the cultures last.

Group III — Patients with a majority of cultures positive: This group includes 34 patients. There were 22 females and 12 males, with lesions unilateral in 12, bilateral in 22, and moderately advanced in 25, minimal in six and far advanced in two. There was at least six months' sanatorium observation, though the average stay was 16 months. All sputum and gastric concentrates were negative. There was a total of 1099 negative concentrates (689 sputum; 410 gastric), an average of 33 per patient. The negative cultures totaled 156 (141 gastric; 15 sputum), or 4.7 per case. There were 294 positive cultures (274 gastric; 20 sputum) or nine per patient. The roentgenologic changes associated with the positive cultures are outlined in Table 3.

In every patient in this group roentgenologic changes occurred. This indicates that the more frequently the cultures are positive in any individual case, the greater the likelihood of unstable active tuberculosis. Moreover, progression was the end status of the lesion in 20 patients (59 per cent) and had also occurred in three others (9 per cent) before final resolution. Progression of the lesion took place more often in this group than in any other. Resolution occurred in 11 patients, or 32 per cent of the group.

1) Twenty-eight of the patients had exudative-productive lesions, though in 15 of them there were questionable areas of cavitation. In these cases the positive cultures were associated with the following changes: (a) In 11 the positive cultures were found

TABLE 3

Group III — Roentgenologic Changes Associated with Positive Cultures

Type of Infiltration	No. of Cases	None	Progression	Resolution, Then Progression	Progression, Resolution, Then Progression	Resolution	Progression, Then Resolution	Progression, Resolution, Progression, Resolution
Exudative-Productive	28	0	11	5	2	9	1	0
Silico-Tuberc.	1	0	0	0	0	1	0	0
Pneumothorax	1	0	0	0	0	0	1	0
Productive-Fibrotic	1	0	0	0	0	0	0	1
Cavitation	3	0	2	0	0	1	0	0
TOTAL	34	0	13	5	2	11	2	1

with the admission infiltration and then progression occurred at various intervals thereafter. The cultures, therefore, preceded progression but in four cases there was not an actual increase in the extent of the lesion but cavitation became definite. (b) In five, resolution first took place and then progression occurred with definite cavitation apparent in one. (c) In two there was a series of changes—progression, then resolution, and finally progression again. Therefore, in 18 of these 28 patients with exudative-productive lesions, progression or cavitation occurred ultimately with the positive cultures. (d) In nine the positive cultures were present with resolution of the lesion. In several the resolution was only slight in extent. (e) In one, slight progression was followed by resolution. Ten of these patients received pneumothorax while in the sanatorium (two of them bilateral). In nine of them the cultures became and remained negative after an effective anatomic collapse.

It should be emphasized that these positive cultures occurred as the only bacteriological evidence of tuberculosis, all the sputum and gastric concentrates being negative. Many roentgenologic changes occurred with the cultures (progression, cavitation, closure of cavities, resolution, and alteration in pneumothorax) showing their sensitivity as an indication of the instability of the lesions.

If cultures remain persistently positive with unchanged x-ray findings, questionable rarefaction or a lesion difficult to interpret because of atypical location, the tuberculosis should be considered active, for in many cases under these circumstances the positive cultures precede progression. Persistently positive cultures should be considered to have the same clinical significance as positive sputa. Even if the positive cultures are associated with resolution, (particularly if there are questionable annular areas) the tuberculosis may still be active for progression can follow resolution.

In 12 of these 28 cases bronchoscopies were done. Four patients were negative, two revealed mucopurulent pulmonary drainage, one a check-valve mechanism, three showed edema of the mucous membrane and two had granulomatous changes. It was not probable that these bronchial lesions alone caused the positive cultures as there was no bronchial ulceration or caseation.

2) In the patient with silico-tuberculosis (third stage silicosis) every culture was positive the first year and all but three were negative the second year. Although the x-ray showed little change with slight resolution, the cultures became negative. Because the silicosis was so massive, the healing of the tuberculosis was not obvious.

3) In the pneumothorax case the positive cultures were associated with no changes for a few months, then an annular area

became apparent. As the collapse was increased the annular area disappeared.

4) One patient had a productive fibrotic lesion. The positive cultures preceded progression on two different occasions and resolution occurred after each spread. With fibrosis established, the cultures finally became negative.

5) Three patients were admitted with definite cavitation. Extensive changes occurred with the positive cultures in each case and in two the cavities became larger, and in the third, the cavity closed.

As regards follow-up of the 34 patients in Group III, 15 (44 per cent) were satisfactory, 11 (32 per cent) unsatisfactory, two (6 per cent) dead, and six were not reported. All of the unsatisfactory results (except for one patient with cavitation) and the deaths were in the patients with exudative-productive lesions. The follow-up results are poorer in this group with the majority of cultures positive than in any other group. This again indicates that the more often the cultures are positive, the more probable the presence of active unstable tuberculosis. The final observation occurred during the first year after discharge in 15 cases; from one to two years in six, from two to three in seven, and six were not followed.

There have been many other cases seen in whom a majority of the cultures were positive as in Group III where in addition, positive concentrates were present for one to several months. The conclusions concerning the correlation of the positive cultures and the roentgenologic changes in these patients are similar to those reached for the Group III cases. However, other observations were also made. In the patients with progression the positive cultures usually preceded the positive gastric and sputum concentrates. On the other hand, with resolution or closure of cavitation by bed rest or collapse measures, usually the sputum concentrates became negative first, the gastric concentrates next, then the sputum cultures and finally the gastric cultures. Occasionally, in thoracoplasty, the persistence of positive cultures may be due not to a slow healing process but an active lesion. In one case a suspicious residual cavity was confirmed by tomography and positive sputum followed the positive cultures. Persistently positive cultures in the presence of a good unilateral pneumothorax would often precede contralateral progression, and after bilateral pneumothorax, the cultures became negative. Positive cultures with a poor pneumothorax collapse obviously meant active disease and preceded progression and positive concentrates. In other words, persistently positive cultures with pneumothorax could indicate uncontrolled tuberculosis in the pneumothorax lung or an on-coming contralateral spread.

There has been an occasional exception to the statement that positive cultures lack significance in productive lesions. Occasionally in such patients with questionable annular areas or moth-eaten lesions, or characteristic productive infiltration with an observation period of many years, progression and positive sputum would occur.

Cultures are also important in their relationship to symptomatology and progression. There may be no symptoms prior to progression when the sputum is negative but the cultures positive, and this condition may continue for months. Symptoms will then appear only with the actual spread of the lesion. Therefore, the persistently positive cultures without symptoms being present indicate that the disease is unstable.

Discussion

We have tried to determine the significance of single, occasional and frequent positive cultures and to evaluate them in the general supervision and treatment of patients with tuberculosis. This is an important problem as there is no unanimity of opinion in the interpretation and practical application of positive culture reports. Some clinicians claim that cultures are too sensitive to be used as a guide in the treatment of tuberculosis and that they can be positive in many cases of tuberculosis without being significant and are associated with slight or unimportant changes in the lesion. We do not subscribe to this belief. We have outlined the circumstances under which little or much emphasis could be placed on positive cultures. There are other impressive reasons why culture examinations should be done as a routine laboratory procedure.

One of the factors that determines the significance of positive cultures is the frequency of the positive reports. A single or occasional positive culture may have little or no importance, but the more often the cultures are positive, the more significant they are of active disease. There were no roentgenologic changes associated with the positive culture in 76 per cent of the patients with a single positive culture (Group I), in 36 per cent of the patients with an occasional positive culture (Group II) but in none of those with a majority of the cultures positive (Group III). There are conditions described for Group II cases where even occasional positive cultures may be of consequence.

Positive cultures may occur under various circumstances: (a) as the only bacteriological evidence of tuberculosis; (b) with resolution of infiltration or increase of fibrosis; (c) prior to and with progression; (d) as indicative of unsuccessful collapse therapy; (e) with variations in the degree of pneumothorax; (f) with gradual healing in thoracoplasty and pneumothorax cases.

The presence of positive cultures should warrant extra roentgenologic and laboratory examinations (frequent and consecutive concentrates and cultures). Special studies like tomography might also be indicated to evaluate the lesion. The additional information obtained will help determine the significance of the cultures.

For a more accurate determination of the clinical status of the patient, both the cultures and roentgenograms should be considered important. Some clinicians claim that more can be judged about the supervision of their cases by repeated roentgenograms than from cultures. However, to use the roentgenograms alone may lead to mistakes in management and therapy. This is not meant to belittle the value of x-ray findings as they are important, and in many cases, can even serve as the principal means of observation. The cultures are, however, also necessary as they help in evaluation of the patient's condition and determination of prognosis and treatment.

There are limitations in the use of cultures. The cultures are not necessarily correlated with the x-ray findings. There may be roentgenologic changes with negative cultures and no changes with positive cultures. On the other hand, in many of our cases, particularly Groups II and III, roentgenologic changes occurred with all sputum and gastric concentrates negative and only the cultures positive. The alteration in the lesion may be gradual or rapid, with ultimate definite resolution or progression yet the roentgenogram may be the same with many of the positive cultures.

The presence of positive cultures without roentgenologic changes may be due to the fact that alterations in the lesion do occur that are not discernible by x-ray examination. It has also been noted (Amberson) that small calcific areas may appear in lung parenchyma formerly considered normal, indicating that healing had taken place in lesions that had not been observed. Sometimes lesions may also be hidden from view.

Although cultures are so sensitive that they may be positive with resolution, patients do finally become negative with stability of the tuberculosis achieved by rest or effective collapse measures. Without the use of routine cultures the appearance of progression and other roentgenologic changes may be unexpected and come as a surprise. The cultures are sensitive and can warn of oncoming changes and indicate instability of the lesion and active tuberculosis. Positive cultures in spite of negative sputum, an unchanged x-ray, or even resolution, may precede progression of the lesion. If the cultures are considered with importance the patient will be observed carefully and without an increase of exercise until the status of the lesion has been determined. Other-

wise with disregard of the cultures and the patient kept ambulant, progressions may occur which could have been prevented.

Cultures also help to indicate therapy. Treatment may not be too difficult to determine when, even with the sputum negative, the positive cultures are associated with a lesion evidently active or progressive. But if the roentgenograms are unchanged persistently positive cultures may still indicate rest or collapse therapy as the cultures can be more expressive of alterations in the lesion than the x-ray. If the infiltration is not visualized clearly within a collapsed lung, the cultures can help determine the efficacy of the treatment. From the roentgenogram alone one could not know the end result or value of the therapy.

In addition to changes in the lesion due to tuberculosis, intercurrent bronchopulmonary infections of a nontuberculous nature may disturb a quiescent pulmonary tuberculous focus and cause a temporary appearance of tubercle bacilli. In almost all of the productive-fibrotic lesions the positive cultures, even when frequent, seemed to have little significance because of the lack of immediate or late changes in the infiltration.

Because of the findings in this study we would suggest that the criteria of the National Tuberculosis Association for the discharge of patients from tuberculosis institutions should be modified to require the routine use of culture examinations and to have them negative before classification of patients as arrested. Patients may have unchanged x-ray findings for a period of months with sputum and gastric concentrates negative and therefore be considered stable, and then progression may occur. A more accurate idea of the status of the case could be determined by the utilization of cultures. Positive cultures, during an apparent period of stability, may warn of unstable disease or impending changes, while negative cultures would indicate the true condition of arrest.

CONCLUSIONS

This is a study of 107 cases with all sputum and gastric concentrates negative and only cultures were positive. The patients have been considered in three groups: those with a single, occasional, or majority of the cultures positive. We have observed other patients with a similar grouping of positive cultures who also had occasional positive sputum or gastric concentrates. The positive cultures have been correlated with the type of infiltration, roentgenological changes, clinical condition, course of the disease, treatment, other laboratory findings and the period of follow-up observation.

Conclusions concerning the significance of the positive cultures as related to the factors mentioned above have been presented.

CONCLUSIONES

Es este un estudio de 107 casos en los cuales todos los concentrados del esputo y del contenido gástrico fueron negativos y sólo los cultivos fueron positivos. Se han considerado a los pacientes en tres grupos: aquellos que resultaron positivos en sólo un cultivo, en unos pocos cultivos o en la mayoría de los cultivos. Hemos observado otros grupos semejantes de pacientes con cultivos positivos que, ocasionalmente, también tenían positivos concentrados del esputo o del contenido gástrico. Se han correlacionado los cultivos positivos con el tipo de infiltración, alteraciones roentgenológicas, condición clínica, evolución de la enfermedad, tratamiento, otros hallazgos de laboratorio y el período de observación subsecuente.

Se han sacado conclusiones acerca del significado de los cultivos positivos en relación a los factores mencionados.

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Discussion

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The results of Dr. Bobrowitz's study respecting the significance of positive cultures in the prognosis of pulmonary tuberculosis are in agreement with those of Dr. Chang of Rutland State and Dr. Abeles of the Montefiore County Sanatorium. They substantiate what physicians have known from practical experience for many years, namely, that all else being equal, the prognosis of patients with pulmonary tuberculosis who eliminate tubercle bacilli on rare occasion is infinitely better than of those who expectorate tubercle bacilli continuously or even intermittently.

With refinements in techniques of sputum examinations, arbitrary divisions between relative paucity or richness of bacilli in the sputum, depending on the methods used, are becoming increasingly more academic. We know that seldom does one fail to isolate tubercle bacilli in patients with active pulmonary tuberculosis. The practical problem is how are we to evaluate the sig-

nificance of sputum examinations in the management of individual patients. Should one adopt the fatalistic attitude expressed by one of our English colleagues to the effect that a patient with pulmonary tuberculosis cannot be said to be cured of his disease until he is safely dead or shall we adopt the policy of neglecting the occasional occurrence of acid-fast organisms if the patient is in good condition and the x-rays reveal stabilized disease.

I believe a satisfactory solution is feasible on the basis of established facts. If a patient has tubercle bacilli in the sputum or gastric contents, either on direct smear or in the *majority* of cultures, that individual should be treated as one with active pulmonary tuberculosis. If acid-fast organisms are found only in a *minority* of the cultures, the patient's status may be considered quiescent depending on other factors such as the age, the existence of an apparently adequate collapse of the lung, the appearance of the x-ray films, and constitutional signs. In the assesmment of this particular group, careful note should be made whether or not these patients have recently had streptomycin with its known temporary suppressive effect on the tubercle bacillus. Patients who show acid-fast organisms on culture *on rare occasion after a lapse of two years,* during which time most reactivations of tuberculosis take place, should be considered as having the disease arrested. The term "arrested" should be retained in our nomenclature because of the important effect it has on patients' morale. After a patient has chased the cure for two years, a physician should have something else to offer him than to say the disease is inactive. The significance of occasional cultures can be explained at this time as well as the importance of having periodic chest examinations. The classification proposed is practical. It does not minimize the significance of the occurrence of rare tubercle bacilli in patients with clinically arrested disease. At the same time, it takes into consideration the fact that the final decision depends on a review of the entire status of the individual patient rather than on the results of the bacteriological examinations alone.

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In any case of tuberculosis, our rationale of treatment must be based on our concept of the nature of the pathology and the inherent quality of response of the patient's tissue to the invading germ. A clear knowledge of the existing disease gives some clue as to its future natural history. A productive lesion has been shown from experience to be relatively benign while a caseous one is more malignant. The whole background is colored by the patient's

reactivity or resistance to the disease. Unfortunately for an exact evaluation of some of these factors, the disease process is usually subsurface and not available for direct examination. We are forced, therefore, to rely upon indirect methods, chief of which are x-ray and sputum studies.

Our image of the underlying disease can only be as accurate as our indirect methods of examination. X-ray study is an admirable example of this hypothesis. As the exactness of our examination has improved, so has our knowledge of the pathological process. Tomography now reveals cavity which was formerly unsuspected and serves to explain some of the previously baffling courses of the disease. Sputum studies have likewise become more exact with our advancement in technique. Concentration methods reveal bacilli where plain smears were negative. Cultural methods still further perfect our search beyond the concentration technique and Dr. Bobrowitz has added statistical proof in support of its value.

The purpose of these studies, of course, is to tell us the nature of the underlying pathology and its progress toward healing or otherwise. The presence of bacilli in the sputum obviously means caseation. When many bacilli are present, it is probable that the area of caseation is relatively large. Conversely, few bacilli indicate a relatively small area of caseation and true disappearance of the organisms must mean healing. The presence of free bacilli in the bronchial tree is significant not only as an indicator of the type of pathology and its state of healing but also as a prognosticator of future events. The increasing incidence of relapse in proportion to the increasing frequency of positive cultures as shown by Dr. Bobrowitz is extremely significant.

The therapeutic course which the clinician will follow in the individual patient whose sputum is positive on culture and negative by other methods of study must be guided by his concepts of the underlying pathology, the efficacy of the available methods of treatment, and the patient's ability to cope with his infection. No two patients are exactly alike. As always, the treatment must be tailored to fit the individual pattern. It is not within my scope to further discuss this angle. Suffice to say that anything which improves our ability and accuracy in reaching this decision is bound to be of value to the patient. Sputum cultures are in this category and should be made use of wherever possible.

Fibromyxoma of Pleura: Report of Case

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As far as we have been able to determine, 31 cases of giant subserous areolar-tissue tumor of the pleura have been reported in the literature. To the best of our knowledge, Neumann[1] has reported the only case in which such a tumor occurred in a child. We shall report another case in which this type of tumor occurred in a child.

REPORT OF CASE

A white girl, aged 2 years, was brought to the Evangelical Hospital, in Chicago, Illinois, on January 14, 1948, because of acute respiratory symptoms and anorexia of three weeks' duration. At birth, her color and cry had been good. She had weighed eight pounds and two ounces (3.7 kg.) at birth and 18 pounds and 6 ounces (8.25 kg.) at the end of six months. Her development had been normal; she had sat up at five to six months, had stood at 10 months, had walked at 12 months, and had talked at 14 months. She had had chicken pox at the age of one year. During the second year, her health apparently had been good. She had not been taken to the family physician for fourteen months before she was brought to the hospital.

Physical Examination: The patient was a fretful, well developed child who weighed approximately 30 pounds (13.6 kg.). The rectal temperature was 103.8 degrees F. (39.9 degrees C.). The respirations were short and shallow, and the respiratory rate was 40 per minute.

Inspection of the thorax disclosed an increased antero-posterior diameter, widening of the interspaces, and decreased expansion on the left side. Tactile fremitus was absent on the same side. The percussion note was flat to dull over the entire left side of the thorax, whereas hyperresonance was present over the lateral portion of the right side. Auscultation revealed absence of breath sounds over the left side, except along the sternal border and in the supraclavicular space, where distant vesicular breathing was audible.

The apical impulse of the heart was palpable in the right xiphocostal angle. Auscultation of the heart disclosed a regular rhythm and a rate of 130 beats per minute. The heart sounds were audible only to the right of the sternum. The liver could be palpated easily, but the spleen was not palpable. The physical examination did not disclose any other significant abnormality.

Laboratory Data: The urine was normal. The erythrocyte count was 4,500,000 and the leucocyte count varied between 12,400 and 17,500 per cubic millimeter of blood, respectively. The concentration of hemoglobin was 11.5 gm. per 100 cc. of blood. The percentage distribution of the leucocytes was as follows: polymorphonuclear neutrophils, 60 per cent; lymphocytes, 30 per cent, and monocytes, 10 per cent. The sedimentation

rate of the erythrocytes was 27 mm. in one hour (Westergren's method). The results of Vollmer's patch test for tuberculosis and Kahn's test for syphilis were negative. No sputum was available for examination.

Roentgenograms of the thorax were suggestive of a massive pleural effusion on the left side, which had displaced the trachea, mediastinum and heart to the right, and had produced partial atelectasis of the right lung (Fig. 1).

Clinical Course: The patient did not show any evidence of improvement during the 13 days that she was in the hospital. Her temperature fluctuated between 97.8 and 99.8 degrees F. (36.6 and 37.7 degrees C.). The pulse rate varied between 110 and 140 and the respiratory rate ranged between 30 and 40 per minute, respectively. Because of the presence of severe cyanosis, the patient was placed in an oxygen tent and 100 per cent oxygen was administered. Twenty-five thousand units of penicillin, in the form of an aqueous solution, were administered intramuscularly, every three hours. The cyanosis recurred only when the administration of oxygen was discontinued while the patient was being examined.

On two different days, thoracentesis was attempted in the fifth, sixth, seventh and eighth interspaces posteriorly and laterally on the left side, but yielded only a few drops of blood. The trocar transmitted the sensation of probing solid tissue. On the assumption that the patient had an intrathoracic neoplasm, she was transferred to the chest service at the Wesley Memorial Hospital on January 26, 1948. Cyanosis and dyspnea were present when the patient was admitted to this hospital, and thoracentesis yielded about 3 cc. of blood, which did not contain any tumor cells. The signs of respiratory distress increased, and the patient died on the evening of the day of admission.

Necropsy: Necropsy was performed under the supervision of Dr. Thomas C. Laipply, Associate Professor of Pathology, Northwestern University School of Medicine, and pathologist at the Wesley Memorial Hospital.

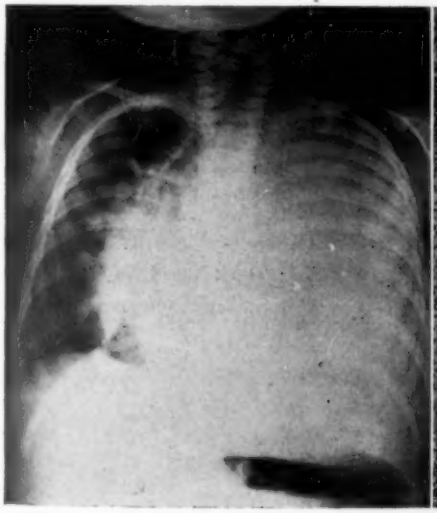

FIGURE 1

FIGURE 2

Fig. 1: Displacement of heart and trachea to right, and compression of right lung due to expansive growth of left pleural tumor.—*Fig. 2:* Loose fibroblastic connective tissue with stellate cells intermixed with more compact, darker staining cellular areas; hematoxylin and eosin stain (x420).

TABLE 1: Data in 32 Reported Cases of Giant Tumor of the Pleura

Case	Author	Date	Country	Age, yrs.	Sex	SIZE OF TUMOR — Dimensions, cm.	SIZE OF TUMOR — Weight, gm.	SITE OF ORIGIN — Thorax	SITE OF ORIGIN — Pleura	Pathologic Diagnosis
1	Feron[2]	1862	France	24	F		10,000			Fibroma
2	Kahler[3]	1882	Bohemia	53	F	20 by 20 by 12		Right	Visceral	Fibroma
3	Kidd and Habershon[4]	1898	England	18	F			Left	Visceral	Myxosarcoma
4	Podack[5] (case 3)	1899	Germany	53	M	33 by 20 by 15		Left	Visceral	Fibrosarcoma
5	Israel-Rosenthal[6] (case 1)	1900	Norway	19	M	20 by 15		Right	Visceral	Round-cell sarcoma
6	Schmidt[7]	1903	Germany	53	M	9 by 5 by 4		Left	Visceral	Fibroma
7	Torri[8] (case 3)	1905	Italy	67	F			Right	Visceral	Sarcoma
8	Henke[9]	1906	Germany	70	F	Size of child's head				Sarcoma
9	Mehrdorf[11] and Braun[10]	1908	Germany	43	F	25 by 11 by 19	3,270	Right	Parietal	Fibrosarcoma myxomatoides
10	Ricard[12]	1908	France	Young	F		6,000	Left		Sarcoma
11	Garre and Quincke[13]	1912	Germany	49	M	11 by 12 by 4; 17 by 14 by 6*	1,250	Left	Parietal	Spindle-cell and round-cell sarcoma
12	Dorendorf[14]	1914	Germany	51	F	25 by 24 by 16	2,900	Left	Parietal	Fibrosarcoma
13	Rosenberger[15] (case 1)	1916	Germany	65	F			Left	Parietal	Round-cell sarcoma
14	Pallasse and Roubier[16] (case 2)	1916	France	51	F		2,200	Left	Parietal	Malignant fibroma
15	Palasse and Roubier[16] (case 3)	1916	France	59	M	30 by 20	5,100	Right	Parietal	Benign fibroma

16	Schneider[17]	1924	Germany	73	F	15 by 9 by 6		Left	Parietal	Fibrosarcoma
17	Nevinny[18]	1927	Germany	43	F			Right	Visceral	Sarcoma
18	Sala[19]	1930	United States	40	F		1,765	Right	Parietal	Fibrosarcoma
19	Klemperer and Rabin[20] (case 1)	1931	United States	48	F	16 by 15 by 7		Left	Visceral	Fibrosarcoma
20	Klemperer and Rabin[20] (case 2)	1931	United States	53	M			Left	Visceral	Spindle-cell myxosarcoma
21	Klemperer and Rabin[20] (case 3)	1931	United States	50	F	19 by 10 by 10		Right	Visceral	Embryonic connective-tissue tumor
22	Lichtenstein[21]	1931	Germany	50	M	18 by 11; 5 by 4†		Left	Parietal or Visceral	Sarcoma
23	Unger[22]	1932	Germany	55	F	27 by 20 by 14		Right	Parietal	Fibroma
24	Cabot,[23] Case No. 18452	1932	United States	55	M		8,000	Left	Parietal	Fibrosarcoma
25	Lyssunkin[24]	1933	Germany	19	F	19 by 14	1,300	Right	Visceral	Sarcoma
26	Neumann[1]	1933	Germany	2¾	F			Left	Parietal	Sarcoma
27	Mintz[25]	1935	United States	64	F	15 by 25 by 8	1,275	Right	Parietal	Fibroma
28	Fawcett[26]	1945	England	48	M			Right	Visceral	Fibroma
29	Belleville[27]	1945	Argentina	53	M	26 by 20 by 8	2,500	Left	Visceral	Fibroma
30	Fernandez Luna[28]	1946	Argentina	60	M	26 by 16 by 16		Left	Visceral	Fibrosarcoma
31	McNamara, Sargent and Costich[29]	1947	United States	55	M	28 by 16 by 14	4,600	Left	Parietal	Sarcoma
32	Hauch and Sittler	1949	United States	2	F	17 by 10 by 8.5	1,190	Left	Parietal	Fibromyxoma

*Tumor presumably removed in 2 sections.

†Tumor removed in 2 sections.

It disclosed that the left side of the thorax was completely filled by a large firm mass which had compressed the left lung markedly and had pushed all of the mediastinal structures, including the heart, to the right of the midline. There were many fibrinous adhesions between the mass and the parietal pleura and between the edges of the compressed visceral pleura and the mass. The mass was well encapsulated in a smooth glistening membrane. It was ovoid in shape, weighed 1,190 gm., and measured 17 by 10 by 8.5 cm. The external surface was slightly lobulated in appearance. In the upper pole of this mass there was a cyst which measured 3 by 4 cm. and contained clear, dark, greenish yellow fluid. The wall of the cyst was of moderate consistency and resistance to section and was 0.1 cm. thick.

The left lung was compressed against the medial and posterior surfaces of the mass. Neither lobe crepitated when palpated. The lobes of the right lung were firmer than normal. Palpation of these lobes revealed a moderate decrease in crepitation.

Microscopic examination revealed that the tumor was composed of embryonic connective tissue. In some areas, the cells were stellate and contained a great deal of myxomatous material; in other areas, the cells were compact and markedly basophilic. A few mitotic figures were observed. Hemorrhage and slight necrosis were observed in some sections. The final anatomic diagnosis was as follows: fibromyxoma of the parietal mediastinal pleura on the left side of the thorax (Fig. 2), slight bronchopneumonia of both lungs, and marked atelectasis of the left lung.

Comment

Modern advances in thoracic surgery have stimulated clinicians to consider the possibility of giant pleural tumors in the differential diagnosis of diseases of the thorax. Consequently, reports of such neoplasms have become more frequent and their study has been more thorough. The geographic distribution of reported cases has also shifted decidedly in the past two decades. Of the nine cases of giant tumor of the pleura which were reported from 1908 to 1927, inclusive, all were reported in the European literature; of the 15 cases that have been reported subsequently, 10 were reported from the Americas and 5 from Europe (Table 1).

Operation was performed in two of the 17 cases which were reported prior to 1928. In both of these cases, the patients survived. Thoracotomy was performed in five of the 15 cases which have been reported since 1928. In one of the five cases, the patient died in the hospital. If large tumors of the pleura are not excised, they continue to grow and eventually interfere with the pulmonary circulation and cause anoxic anoxia.

Giant connective-tissue tumors of the pleura affect females more frequently than they affect males. In the 32 reported cases, including the case which we have just reported, 62.5 per cent of the patients were females and 37.5 per cent were males. The incidence was highest in persons in the sixth decade (Table 2).

These tumors of the pleura have three interesting features:

(1) clinically, they resemble a massive pleural effusion; (2) they originate in various portions of the pleura, and (3) although the clinical signs and symptoms and the macroscopic appearance indicate that these tumors are benign, histologic examination, usually, indicates that they are malignant.

A large pleural tumor filling one side of the thoracic cavity presents a clinical and roentgenologic picture of massive pleural effusion. In two thirds of the cases under consideration, pleurocentesis was attempted but fluid was obtained in only one case. The trocar usually felt as though it was imbedded in solid tissue, and Garre asserted that this feeling was so characteristic as to be diagnostic.[13]

Pathologists have invariably discovered numerous loose attachments between these giant pleural tumors and the costal, mediastinal, diaphragmatic, pericardial and visceral pleurae; hence, they have encountered difficulty in specifying the exact points of origin. The primary sites of the neoplasms reported in the literature were equally distributed between the visceral and parietal layers of the pleural membrane, and were encountered more often on the left side (60.0 per cent) than on the right side (40.0 per cent) of the thorax (Table 1). Feron,[2] Henke,[9] and Ricard[12] failed to establish the sources of origin of the huge tumors in their cases. Lichtenstein[21] felt that the growth he described could have arisen from either the mediastinal or visceral pleura. In the case reported herein, the prosector found fibrinous adhesions between the tumor and both the parietal and visceral surfaces of the pleura. According to Rokitansky[30] and Clagett and Hausmann[31] a tumor which does not possess a pedicle or is not attached to the pleura by dense fibrous bands must be considered to have become para-

TABLE 2

Age of Patients by Decades in Cases of Giant Connective-Tissue Tumors of the Pleura

Age in Years	CASES	
	Number	Per cent
0 to 9	2	6.5
10 to 19	3	9.6
20 to 29	1	3.3
30 to 39	0	
40 to 49	6	19.4
50 to 59	13	41.8
60 to 69	4	12.9
More than 70	2	6.5

sitic within the pleural cavity. As the exact site of origin of these pleural tumors was often problematical at necropsy, it must be expected that their relationship to adjoining structures and their attachments would be even more difficult to delimit during thoracotomy. Hence, conclusive evidence is lacking as to whether or not the huge tumors reported by Doege,[32] Susman,[33] and Clagett and Hausmann[31] arose from the pleura or within the mediastinum. In Belleville's[27] case, pleuroscopy suggested that there was a pedicle attached to mediastinal structures, but subsequent surgical excision revealed that the pedicle arose from the hilum of the lung.

That these neoplasms might be clinically and macroscopically benign but histologically malignant was first suggested in the earlier German literature, and was confirmed by Nevinny,[18] Klemperer and Rabin,[20] and Lichtenstein.[21] The last author classified pleural tumors into three groups. The first two groups included tumors that were frankly malignant, and the third was composed of the "benign" giant tumors of the pleura. According to Table 1, the tumors were histologically malignant in 22 (68.7 per cent) of the 32 cases. Nevertheless, all the tumors were well encapsulated and did not metastasize or invade the surrounding tissues. Kaufmann[34] and Brunner[35] have each reported a case of a huge localized neoplasm of visceral pleural origin which had metastasized.

In 1933, Neumann[1] reported a case in which the patient was a girl, 2¾ years of age. The symptoms and the laboratory, roentgenologic and postmortem findings in this case were similar to those in the case which we have reported in this paper. Except for the loss of weight, the palpable spleen and the clubbing of the fingers, the physical findings in his case were similar to those in our case. Neumann stressed the significance of the flat percussion note together with the firm fixation of the trocar between the ribs as clinical evidence of a dense pleural mass. Although the results of the first pleurocentesis were negative, a second puncture yielded a few particles of tissue which, microscopically, were composed of spindle cells and atypical giant cells. The final pathological diagnosis in his case was spindle-cell sarcoma of the left costal pleura. The tumor had filled the left thorax and had compressed the mediastinum to the right side, but it had not metastasized.

SUMMARY

This paper is based on the report of a case of giant localized, connective-tissue tumor of the pleura in which the patient was a girl, aged 2 years. As far as we have been able to determine, this is the second report of a case in which this type of tumor

has occurred in a child. It is evident that more cases of this tumor have been reported in the past two decades than had been reported previously. If these tumors are not excised, they will continue to grow and will impede the function of vital organs within the thorax. The possible presence of large tumors of the pleura must be considered in the differential diagnosis of diseases of the thorax which simulate massive pleural effusion. The site of origin of these growths appears to be subserous areolar tissue of either the parietal or visceral pleura. Although clinically they are benign, these neoplasms are usually histologically malignant. This case re-emphasizes the need for frequent periodic physical and roentgenographic examinations to detect the presence of unusual but fatal lesions during their early asymptomatic phase.

RESUMEN

En este trabajo se refiere un caso de un gigante tumor localizado del tejido conectivo de la pleura, en una niñita de 2 años. Hasta donde hemos podido averiguar, éste es solamente el segundo caso referido de este tipo de tumor que haya ocurrido en un niño. Es evidente que se ha informado sobre un mayor número de casos de este tumor en las dos últimas décadas que en todo el tiempo anterior. Continúan creciendo estos tumores si no se los extirpa, hasta que llegan a impedir el funcionamiento de órganos intratorácicos vitales. En el diagnóstico diferencial de enfermedades del tórax que se asemejan a derrames pleurales masivos, debe considerarse la posible presencia de grandes tumores de la pleura. Se cree que estos tumores se originan en el tejido aerolar subseroso de la pleura visceral o parietal. Aunque clínicamente son benignos, histológicamente estas neoplasias generalmente son malignas. Recalca de nuevo este caso la importancia de hacer frecuentes exámenes físicos y roentgenográficos para descubrir la presencia de raras, pero fatales, lesiones durante el período asintomático temprano.

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The Transpleural Endoscopic Approach to the Autonomic Nervous System and Its Therapeutic Possibilities*

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Operations on the thoracic sympathetic chain, as in hypertension for example, can be performed simply and without operative risk. After the induction of a pneumothorax, the entire sympathetic trunk, from the caudal portion of the stellate ganglion down to its passage through the diaphragm including its branches to the splanchnics and the rami communicantes, can easily be seen with a thoracoscope, shining through the parietal pleura. Although every anatomical atlas shows these topographical relations, until now this simple route has not been described. After death the parietal pleura quickly thickens and clouds like the cornea so that in the cadaver where new operative procedures are usually tried the vagus and sympathetic are no longer clearly seen. On the other hand, in open thoracotomies the reflex hyperaemia and the brilliant lighting of the operative field obliterates nuances. This may appear paradoxical, but it is the endoscopic illumination that brings out in rich contrast and relief the vegetative nervous system.

By means of thoracoscope and through either one or two openings in the thorax, the sympathetic can be injected or divided by cautery at any given point above the diaphragm. With a suitable instrument exeresis can be done and the nerves from below the diaphragm evulsed. This is not true of the vagus. The upper half is approachable with a direct optic and cautery. The lower half can be reached only at certain points and then with a 90 degree or 135 degree optic and a curved cautery.

In a series of 200 operations no complications were observed, with the exception of three intercostal neuralgias. The procedure is so easily performed that in some patients on the same day and even in the same hour the operation can be done first on the one and then on the other side. The advantages of the endoscopic method are:

1) There is practically no operative risk.

2) The procedure can be repeated. For example, a preliminary novocain block can be done, the therapeutic effects studied, and

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after several days or weeks, a permanent interruption performed. Again as in hypertension with renal involvement, the first intervention (on the splanchnicus) eliminates the vasoconstriction of the kidneys. After an improved renal blood flow and function, the second intervention against the sympathetic can be carried out if necessary.

3) The operation can be performed with a certainty of exact localization, without general anesthesia, and without preliminary sedation, so that many new physiopathologic observations are possible.

In a short communication no discussion of the uses of this method as in hypertension, diseases of the liver, and biliary tract, pancreas, spleen and hemopoietic system, circulatory disturbances, bronchial asthma, and pulmonary tuberculosis can be made.

We wish only to note here that in our treatment of peptic ulcer we interrupt the sympathetic and not the vagus. This treatment will be discussed in another communication.

REFERENCE

Kux, E.: *Ars. Medici.*, 1948, 676.
Acta Chirurg. Belgica, 1948, 285.
dtsche. Mediz. Wochenschr., 1949, 753.

First International Congress on Diseases of the Chest

The First International Congress on Diseases of the Chest, to be sponsored by the American College of Chest Physicians in cooperation with the Forlanini Institute of Rome, will take place in Rome, Italy, in September, 1950. Dr. Attilio Omodei Zorini, Medical Director of the Forlanini Institute, will serve as chairman of the arrangements committee for the Congress. A scientific program covering all phases of diseases of the chest will be presented, as well as an x-ray conference, a motion picture session, round table discussions, and scientific exhibits. Physicians interested in presenting papers at the Congress are invited to submit titles and abstracts of their material to the program committee for consideration. Please send the information to the Executive Offices of the College, 500 North Dearborn Street, Chicago 10, Illinois.

Fourth Annual Postgraduate Course Held in Chicago

The Fourth Annual Postgraduate Course in Diseases of the Chest was presented in Chicago during the week of September 19-23. There were 38 physicians registered for the course representing 17 states and Canada. Dr. Edwin R. Levine served as chairman of the postgraduate course committee with Drs. Paul H. Holinger, Minas Joannides, Darrell H. Trumpe, and Italo F. Volini as members. The committee plans to arrange a similar course in the fall of 1950 to be held in Chicago.

On Thursday evening, September 22, a dinner was held for the instructors and physicians who participated in the course. A photograph of the group may be found on page 628 of this issue of the journal. Dr. J. Winthrop Peabody, Washington, D. C., Chairman of the Council on Postgraduate Medical Education of the College, served as Toastmaster at the dinner and Dr. Richard C. Benkendorf, Bushnell, Illinois, made a brief talk as Valedictorian of the postgraduate class. The physicians who attended the course were as follows:

†Lamar E. Alford, M.D., Cairo, Illinois; John M. Baker, M.D., Columbus, Ohio; E. G. Cada, M.D., Downey, Illinois; Charles A. Castle, Comdr., USN, Great Lakes, Illinois; Ger Au Chan, M.D., Farmingdale, N. Y.; R. C. Benkendorf, M.D., F.C.C.P., Bushnell, Illinois; Raymond C. Comstock, M.D., Louisville, Kentucky; R. P. Empey, M.D., Hamilton, Ontario; *J. M. Filiatrault, M.D., Montreal, Canada; Charles A. Freund, M.D., Chicago, Illinois; Stanley M. Gates, M.D., Little Rock, Arkansas; Allen W. Glinert, M.D., Chicago, Illinois; Morton N. Goldberg, M.D., Fort Worth, Texas; Harry M. Hepperlen, M.D., Beatrice, Nebraska; V. H. Hill, M.D., F.C.C.P., Mobile, Alabama; Curtis R. Hoffman, M.D., Richmond, Indiana; George B. Kimbrough, Lt. (jg), USN, Great Lakes, Illinois; Philippe Landry, M.D., Montreal, Canada; John T. Lane, M.D., Biloxi, Mississippi; Paul V. Ledbetter, M.D., Houston, Texas; †Elizabeth A. Leggett, M.D., Ah.Gwah-Ching, Minnesota; C. L. Lindo, M.D., Chicago, Illinois; Harry H. McCarthy, M.D., Omaha, Nebraska; *D. W. McCauley, M.D., Okmulgee, Oklahoma; H. N. McClelland, M.D., New Castle, Indiana; M. L. McClung, M.D., Indianapolis, Indiana; J. A. Muggly, M.D., Madison, South Dakota; Donald J. Schissel, M.D., Des Moines, Iowa; William W. Stead, M.D., Minneapolis, Minnesota; Paul W. Sunderland, M.D., Gibson City, Illinois; Frank Ryder Trigg, M.D., Norfolk, Virginia; †Raymond P. Wiesen, M.D., Milwaukee, Wisconsin; Carryl W. Wiggins, M.D., Oklahoma City, Oklahoma; J. R.

FOURTH ANNUAL POSTGRADUATE COURSE IN DISEASES OF THE CHEST, AMERICAN COLLEGE OF CHEST PHYSICIANS
SEPTEMBER 19-23, 1949, ST. CLAIR HOTEL, CHICAGO, ILLINOIS

Some of the physicians and instructors who participated in the Fourth Annual Postgraduate Course in Diseases of the Chest of the American College of Chest Physicians

Winston, M.D., Temple, Texas; Russell S. Wolfe, M.D., Houston, Texas; David C. Wu, M.D., Kansas City, Missouri; Marion T. Yates, Comdr., USN, Great Lakes, Illinois; George Zubowicz, M.D., Manteno, Illinois.

*Associate Fellow, American College of Chest Physicians.
†Associate Member, American College of Chest Physicians.

College Chapter News

MICHIGAN CHAPTER

The Michigan Chapter of the College met coincident with the Michigan State Medical Society Annual Convention at Grand Rapids, September 22. A very informative, instructive and highly interesting meeting was held. The dinner was followed by a talk on "Physiology of Pneumoconiosis" by Dr. George W. Wright of Saranac Lake, New York. His talk was followed by a discussion of the paper by Dr. Oscar A. Sander of Milwaukee, Wisconsin, who also made pertinent remarks of great value on dust disease in general and especially siderosis.

The meeting was well attended by the members of the Michigan Chapter of the College and other members of the Michigan State Medical Society, totaling approximately 100. By special invitation a large group of industrial physicians were guests.

C. P. Mehas, M.D., Secretary-Treasurer.

ROCKY MOUNTAIN CHAPTER

The Annual Meeting of the Rocky Mountain Chapter of the College was held Tuesday, September 20, in the Brown Palace Hotel, Denver, Colorado. An interesting program was presented which was attended by more than 80 members and guests. The business session and election of officers were held after the luncheon meeting and the following officers were elected for the ensuing year:

Fred Harper, M.D., Denver, Colorado, President
Robert C. Cook, M.D., Fort Logan, Colorado, First Vice-President
H. M. Van Der Schouw, M.D., Wheatridge, Colo., Second Vice-President
W. Bernard Yegge, M.D., Denver, Colorado, Secretary-Treasurer.

WISCONSIN CHAPTER

The Wisconsin Chapter of the College held its Fifth Annual Meeting at the Schroeder Hotel, Milwaukee, Wisconsin on Sunday, October 2nd. The State Medical Society of Wisconsin held its annual meeting in Milwaukee, October 3-5.

The following program was presented at the chapter meeting:

1:30 p. m. Registration.
2:00 p. m. Scientific Session:

"Antibiotics in the Treatment of Non-Tuberculous Diseases of the Chest,"
Wallace E. Herrell, M.D., Associate Professor of Medicine, Mayo Foundation, University of Minnesota; Consultant in Medicine, Mayo Clinic, Rochester, Minnesota.

"Etiology of Pulmonary Heart Disease,"
Chauncey Maher, M.D., Associate Professor of Medicine, Northwestern University Medical School; Professor of Medicine, Postgraduate School of Medicine, Cook County Hospital, Chicago, Ill.

"Surgical Management of Intractable Bronchial Asthma,"
John B. Grow, M.D., F.C.C.P., Chief, Thoracic Surgery, National Jewish Hospital, Denver; Branch Section Chief, Thoracic Surgery, Branch 13, U. S. Veterans Administration, Denver, Colorado.

"Unusual Findings in Asymptomatic Chest,"
George M. Landau, M.D., Professor of Roentgenology, Postgraduate School of Medicine, Cook County Hospital, Chicago, Illinois.

"Lymphomatoid Disease of the Chest,"
John S. Hirschboeck, M.D., Dean, Marquette University School of Medicine, Milwaukee, Wisconsin.

"Pulmonary Manifestations of Collagen Disease,"
D. Murnay Angevine, M.D., Professor of Pathology; Chairman, Dept. of Pathology, University of Wisconsin Medical School, Madison, Wis.

College News Notes

Dr. Darrell H. Trumpe has been appointed Medical Director of Saint John's Sanitarium, Springfield, Illinois, and Dr. Jesse A. Stocker serves as Assistant Medical Director of the Sanitarium.

Dr. Lamar A. Alford, formerly at Stony Brook Retreat, Keene, California, has taken over his duties as Medical Director and Superintendent of the Alexander County Tuberculosis Hospital, Cairo, Illinois.

Drs. Alvan L. Barach and Chesmore Eastlake, Jr., New York City, and Dr. Maurice S. Segal, Boston, will participate in a symposium on inhalational therapy being presented under the auspices of the New York Academy of Medicine and the New York Association of Oxygen and Ambulance Services, Inc. The symposium will be presented at the Academy Building, New York City, December 5 to 10, inclusive.

Dr. Evarts A. Graham, St. Louis, Missouri, has been honored by the Mississippi Valley Medical Society as its Honor Award Recipient for 1949. The award, consisting of a gold medal and a certificate, was presented at the annual meeting of the society in St. Louis on September 29.

Dr. Edward W. Custer, South Bend, Indiana, has informed us that dedication ceremonies of the remodeled and enlarged Healthwin Hospital, of which he is Superintendent, were held on Saturday, September 18, and attended by more than 600 persons. The principal speaker was Dr. Ernest E. Irons of Chicago, President of the American Medical Assn.

Interim Session, American Medical Association

The Interim Session of the American Medical Association will be held in Washington, D. C., December 6 to 9, inclusive. The General Chairman of this meeting is Dr. Oscar B. Hunter of Washington, D. C., who is the President of the Southern Medical Association. The meeting is primarily for general practitioners. An interesting program on diseases of the chest has been arranged. Dr. Jay Arthur Myers, Minneapolis, Minnesota, is Coordinator for the Committee on Diseases of the Chest; Dr. J. Winthrop Peabody, Washington, D. C., is Sub-Chairman of the Committee. The other members of the committee are: Dr. John W. Trenis, Dr. Daniel L. Finucane, Dr. A. Barklie Coulter, Dr. Sol Katz, Dr. Frank Ashburn, and Dr. Edgar W. Davis, all of Washington, D. C.

The following program will be presented in the session on diseases of the chest:

"Modern Treatment of Cough,"
Andrew L. Banyai, M.D., F.C.C.P., Milwaukee, Wisconsin.

"Pulmonary Infarction,"
Hugh H. Hussey, M.D., Washington, D. C.

"Silent Lesions of the Lung,"
Edwin R. Levine, M.D., F.C.C.P., Chicago, Illinois.

"Bronchiectasis and Lung Cysts,"
Martin J. Sokoloff, M.D., F.C.C.P., Philadelphia, Pennsylvania.

"Physiologic Therapy in Bronchial Asthma and Pulmonary Emphysema with Motion Pictures of Bronchial Asthma and Obstructive Dyspnea,"
Alvan L. Barach, M.D., F.C.C.P., New York, New York.

"Tuberculosis and the General Practitioner,"
Jay Arthur Myers, M.D., F.C.C.P., Minneapolis, Minnesota.

"Chemotherapy in Tuberculosis: Its Integration with other Procedures,"
H. McLeod Riggins, M.D., New York, New York.

"History of B.C.G. and Its Present Day Problems,"
Konrad Birkhaug, M.D., Albany, New York.

"The Approach to Early Diagnosis and Surgical Treatment in Chest Disease,"
Norman Wilson, M.D., Boston, Massachusetts.

"Comments on Mass X-Ray Surveys and Surveys of General Hospital Admissions for Pulmonary Tuberculosis,"
Robert J. Anderson, M.D., F.C.C.P., Washington, D. C.

"Hematogenous Tuberculosis with Emphasis on the Value of Bone Marrow Study for Diagnosis,"
Sol Katz, M.D., Washington, D. C.

"Lipoid Pneumonia,"
A. O. Hampton, M.D., Theodore Winship, M.D., Edward B. McCabe, M.D. and Edgar W. Davis, M.D., F.C.C.P., Washington, D. C.

"A Panel on the Diagnosis and Treatment of the Pneumonias,"
Harry F. Dowling, M.D., Washington, D. C., Moderator.
Thomas McPherson Brown, M.D. and Mark H. Lepper, M.D., Washington, D. C.

"The Pathogenesis, Diagnosis and Treatment of Asthma,"
Maurice S. Segal, M.D., F.C.C.P., Boston, Massachusetts.

"Pleurisy with Effusion, Spontaneous Pneumothorax and Other Diseases of the Pleura,"
Louis L. Friedman, M.D., F.C.C.P., Birmingham, Alabama.

"Aerosol Therapy for Bronchopulmonary Disease,"
Maurice S. Segal, M.D., F.C.C.P., Boston, Massachusetts.

"Trauma of the Lungs and Pleura,"
J. Maxwell Chamberlain, M.D., New York, New York.

"Recent Advances in Fungus Diseases of the Lungs,"
Hyman E. Bass, M.D., F.C.C.P., New York, New York.

"Medication and Practical Principles in the Management of Coughs,"
A. Worth Hobby, M.D., F.C.C.P., Atlanta, Georgia.

"Sarcoidosis,"
Sol Katz, M.D., Washington, D. C.

"Differential Diagnosis of Chest Pain,"
Hugh H. Hussey, M.D., Washington, D. C.

"A Panel on Pulmonary Diseases Due to Inhalation of Certain Organic and Inorganic Dusts with Comments on the Compensation Problems,"
Anthony J. Lanza, M.D., New York, New York, Chairman.
Edgar Mayer, M.D., F.C.C.P., New York, New York and Oscar A. Sander, M.D., F.C.C.P., Milwaukee, Wisconsin.

"Pulmonary Hemorrhage,"
Osler A. Abbott, M.D., F.C.C.P., Atlanta, Georgia.

"The Surgical Management of Bronchiectasis,"
Herbert C. Maier, M.D., New York, New York.

"The Surgical Treatment of Lung Abscess,"
Roy G. Klepser, M.D., F.C.C.P., Washington, D. C.

"Bronchial Obstruction, Clinical and Bronchoscopic Observations,"
Paul H. Holinger, M.D., F.C.C.P., Chicago, Illinois.

"Clinical Aspects of Pulmonary and Mediastinal Neoplasms,"
Foster Murray, M.D., F.C.C.P., Brooklyn, New York.

National Medical Association Creates Section on Diseases of the Chest

The first Annual Meeting of the newly-created "Section on Diseases of the Chest of the National Medical Association," was held in August at the Horace Rackham Educational Building in Detroit, Michigan on the occasion of the Association's 54th Annual Convention. The following program was presented at the Educational Building and at the Rest Haven Hospital:

"The Etiology and Management of Hemoptysis,"
M. R. Hadley, M.D., F.C.C.P., Chief, Tuberculosis Clinic, McKeesport Hospital, McKeesport, Pennsylvania.

"Newer Concepts of Streptomycin Therapy in Tuberculosis,"
W. Roderick Brown, M.D., F.C.C.P., School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania.

"Indications for Surgery in the Treatment of Tuberculosis,"
Arthur G. Falls, M.D., F.C.C.P., Associate Attending Surgeon, Provident Hospital, Chicago, Illinois.

"Mass X-ray Surveys in New Jersey,"
J. Earle Stuart, M.D., F.C.C.P., New Jersey State Health Department, Plainfield, New Jersey.

"The Management of Tuberculosis Complicated by Diabetes,"
Clarence H. Payne, M.D., F.C.C.P., Municipal Tuberculosis Sanitarium, Chicago, Illinois.

"Artificial Pneumothorax,"
G. Leonard Oxley, M.D., Harrisburg Hospital, Harrisburg, Pennsylvania.

"The Use of Para-Aminosalicylic Acid in the Treatment of Tuberculosis,"
R. C. L. Markoe, M.D., F.C.C.P., Medical Director, Fairview Sanitarium, Detroit, Michigan.

"Diagnostic Problems of Carcinoma of the Lung,"
J. Edmond Bryant, M.D., F.C.C.P., Chief, Chest Division, Provident Hospital, Chicago, Illinois.

"Symposium on Diseases of Chest,"
Thomas H. Billingslea, M.D.

The following officers were elected for the ensuing year:

W. Roderick Brown, M.D., F.C.C.P., Chairman
J. Edmond Bryant, M.D., F.C.C.P., Chairman-Elect
Arthur G. Falls, M.D., F.C.C.P., Secretary
J. Earle Stuart, M.D., F.C.C.P., Chairman, Program Committee.

Among the recommendations approved was the suggestion of a demonstration X-Ray Chest Survey of the members of the National Medical Association at the 1950 Convention.

Arthur G. Falls, M.D., F.C.C.P., Secretary.